THE STAR

MODIFICATION 13

FAÇADE REPORT FOR PLANNING APPLICATION

PREPARED BY

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DOCUMENT REGISTER

Date	Revision no.	No. of pages	Issue/Description of Amendment	Prepared by	Reviewed by	Approved by	Signature
01.03.2018	C	19	Final	Angus Johnson	Neil McClelland	Neil McClelland	Neil McClelland

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1 EXECUTIVE SUMMARY

The Star development facades, including to the hotel and residential tower, tower entrances, community centre, podium façades and ribbon roof and cladding elements, have been designed to respond to the environment and context of the site in a positive manner with limited and predictable environmental impacts on the surrounding area relative to what has already been assessed (up to and including Mod 14).

The response of the building to the environmental, including solar heat and glare, has been assessed resulting in a design which controls the requirement for heating and cooling in a responsible and compliant manner. The reflectivity of the building has been considered with the resulting material selections made to predictably reduce reflectivity below mandated local requirements. The proposed glazing has also been benchmarked against existing glazing and has found to a similar or lower reflectivities to what is already installed. The local wind climate, at external areas of the development, has been tested and found to be at acceptable levels for users and within the immediate surrounding area.

The façade and cladding design for The Star, as documented in the Modification 13 Planning Application and as outlined in Figure 1, has been undertaken with reference to the design basis and performance requirements provided in this report. This report represents a summary of the response to the many design parameters and performance considerations to which the skin of the building is required to respond. The parameters provided in this report have been developed based on the Architectural design produced for The Star Modification 13 as well as advice and coordination with other project consultants with reference to the applicable regulatory framework, design codes and standards.

TTW as the project façade consultant have reviewed the development and Modification 13 Planning Application project documents to ensure compliance with the performance requirements detailed in this report.

During the subsequent detailed design development of The Star project, the production of design drawings detailing the façade and cladding portions of the project and the finalisation of all material and performance specifications for each façade type and material finish, this report will be referenced to ensure agreement with the project design parameters.

Additionally, TTW, as the project façade consultant, will undertake activities to ensure that ongoing project design development will further enhance the development and is not likely to have any material impact on the design of the development nor potential environmental impacts:

TTW as the project façade consultant will undertake the following during subsequent project stages:

- participate in consultant workshops and design meetings
- produce additional documentation, drawings and specifications
- review and witness façade prototyping and testing
- undertake ongoing technical reviews of other project consultant documentation
- review material technical and benchmark submissions
- review façade 'Design and Construct' packages produced by specialist facade contractors for compliance with this report and project specifications
- undertake material procurement and production inspections to ensure compliance
- undertake site inspections during the installation of the façade.

The following façade areas and types for the development are covered by this report:

- FA01 – Hotel Tower Façade
- FA02 – Residential Façade
- FA03 – Hotel Sky Lobby Hotel Reception Façade – Double Storey
- Hotel Restaurant Facade
- FA04 – Hotel Tower Club Lounge Façade
- Hotel Tower Club Lounge Terrace – Balustrades
- FA05 – Vertical Slot Eastern, interface to FA01 and FA02 levels on Pirrama Road Elevation
- FA06 – Core Cladding, Green Belts interface to FA01 and FA02 levels on Jones Bay Road Elevation
- FA07 – Neighbourhood Façade, Podium North Elevation
- FA08 – Sandstone Podium Façade
- FA09 – Ribbon Façade Shell
- FA10 – Hotel Entrance, Pirrama Road Podium
- FA11 – Green Wall adjacent to Hotel Entrance, Pirrama Road Podium
- FA12 – Hotel Tower Plant Room Louvred Façade
- FA13 – Residential Podium Level Facade

- FA14 – Jones Bay Window Facade
- FA15 – Glazed Awning, Residential Entrance Jones Bay Road
- FT16 – Pergola Pool Deck
- LV01 – Plant Louvres, Tower Roof Plant Levels
- LV02 – Plant Louvres Automated, Tower Roof Plant Levels

MOD 13 STAGING DIAGRAM

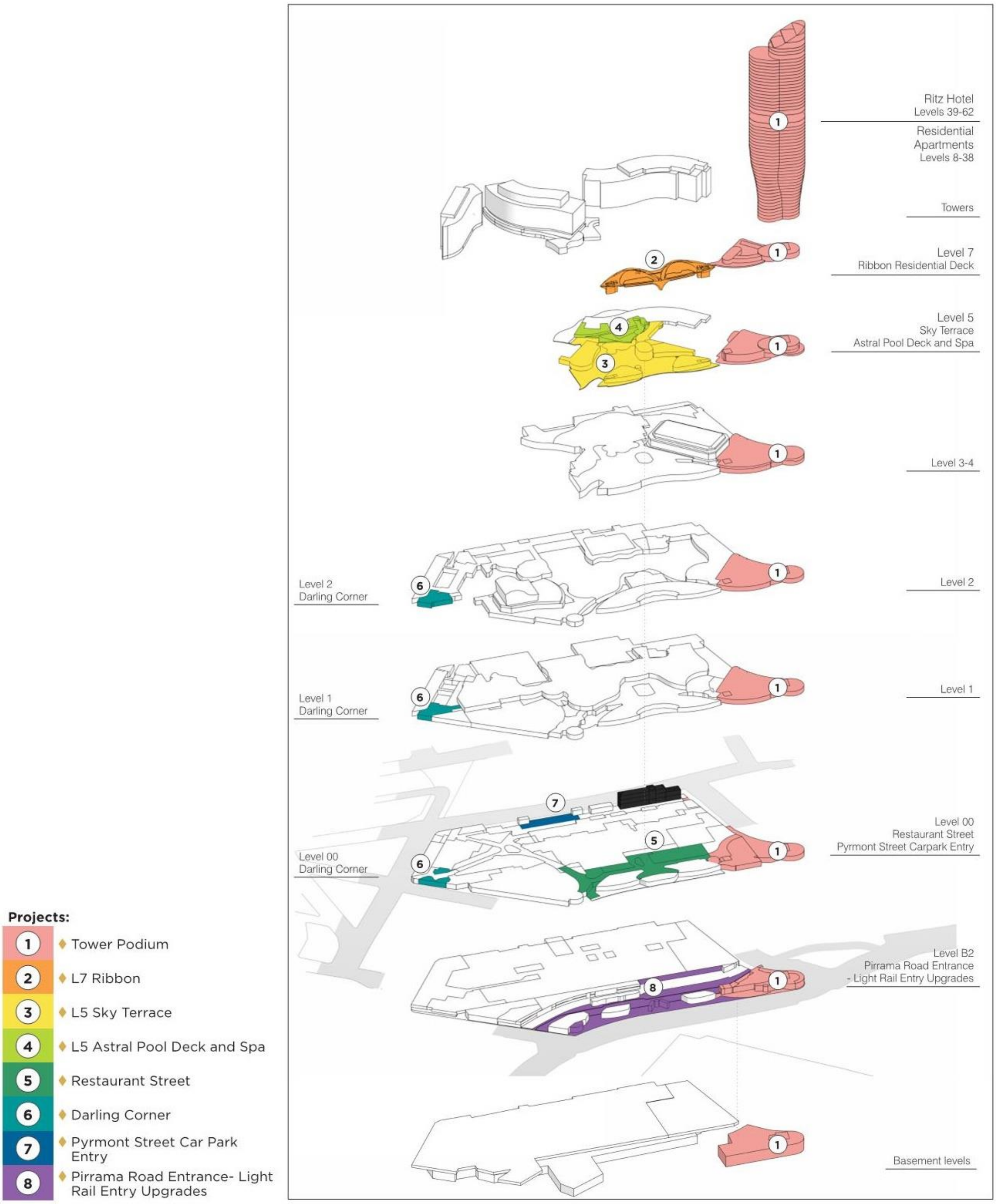

Figure 1

2 DESIGN BASIS FOR FAÇADE DESIGN

Façade and cladding systems for The Star Project have been designed by the project consultant team as represented in the Modification 13 Planning Application. As is traditional for building cladding and façade packages of this sophistication, the final 'For Construction' documentation is produced by a specialist façade and cladding subcontractor with full review and monitoring undertaken by the overall project façade consultant. This final 'For Construction' design and documentation will be produced and reviewed for compliance with this report and the Modification 13 Planning Application.

In undertaking the design of the façade and cladding systems, TTW have complied with all relevant Australian codes and standards including the following mandated Australian Standards. All further development of the façade detailing, specification and testing will also comply with the following design basis provided in this section of the façade report.

2.1 REGULATORY FRAMEWORK, CODES AND STANDARDS

In undertaking the design of the façade and cladding systems, TTW have complied with all relevant Australian codes and standards including the following mandated Australian Standards. All further development of the façade detailing, specification and testing will also comply with the following:

Reference	**Code Description**
NCC 2016	National Construction Code 2016, Volume 1
AS1170 all parts	Structural Design Actions
AS 1288	Glass in buildings – Selection and installation
AS 2047	Windows in buildings – Selection and installation
AS 1664	Aluminium Structures
AS 2208	Safety glazing materials in buildings
AS2312	Corrosion Protection of Structural Steel
AS4100	Steel Structures
AS/NZS 4284	Testing of building facades
AS 4666	Insulated glass units
AS 4667	Quality requirement for cut-to-size and processed glass

Additional material and element design Australian Standards referenced in the mandated standards have been adopted including those relevant to each specific material. Additional recognised product and test data will also be used to confirm compliance with the design and material requirements during design finalisation.

All façade elements have been designed with the requirement that they are not climbable or have horizontal footholds in accessible locations especially at balconies and external terraces.

All overhead, both horizontal and vertical, heat treated glass is specified from a Risk and Safety-in-Design perspective to consider breakage from inclusions and impact where broken glass can fall on people below. Fully tempered or toughened glass is not proposed for the project given it's risk of breakage from inclusions even when heat soaked tested.

During further development of the façade and the final 'For Construction' documentation of the façade the structural strength, deflection and vibration testing of individual façade elements and assemblies may be demonstrated by physical testing to recognised regimes instead of design calculations when these may be deemed overly conservative.

2.2 DESIGN LOADS AND ACTIONS

The building importance level designation is based on the occupancy and nature of the development. Importance Level of 3 has been applied for all areas of the development in accordance with the NCC. All loads and load combinations are in accordance with AS 1170 parts 0 to 4 'Structural Design Actions'.

2.2.1 Material Self Weight

The self-weight of all materials including steel, glass, aluminium, timber, stone and concrete has been included in the design.

2.2.2 Balustrade Loading and Design

Glazed balustrade loading has been calculated in accordance with AS1170.1. Final 'For Construction' design and detailing of all balustrades acting as a barrier will be for actions as indicated in AS/NZS 1170.1 Table 3.3 considering crowding and furniture. Areas of crowd loading and all barrier classifications are confirmed by the project BCA consultant to ensure compliance.

Glass selection and balustrade type has been determined in accordance with AS1288. Cantilevering monolithic glass balustrades will not be adopted and external laminated frameless cantilevering balustrades do not comply with the Deemed to Satisfy (DTS) requirements of the NCC and present an ongoing maintenance liability and degradation risk. As such balustrades with load supporting posts and load supporting interlinking handrails have been adopted.

In areas where the requirement for safety glass has been identified, monolithic toughened glass has not been adopted where breakage would result in glass falling onto people below. Laminated glass assemblies have been adopted which shall be adequately anchored to provide post breakage capture and stability. Safe breakage patterns and glass post breakage behaviour may be demonstrated by prototype tests undertaken by the specialist façade subcontractor.

2.2.3 Impact Loading

Live loads from cleaning and BMU impact are specified to be allowed for in the final 'For Construction' documentation including impact loads and loads from access ropes and equipment over flashings and cappings at parapets and areas of stepped and recessed facades.

2.2.4 Wind Loads and actions

Wind loadings for all elements are designed in accordance with AS1170.2 using the parameters listed below:

Item	**Value**
Building Importance Level	III (Major structures affecting crowds)
Terrain Category	3 (general) 2 (north direction)
Region	A2
Annual Probability of Exceedance	1:1000
Regional Wind Speed	V_R=46m/s

Final 'For Construction' design of all façade elements and their connections to the structure is to include inclusion of all local peak wind pressure effects in accordance with AS/NZS1170.2 local pressure factors. Potentially local pressures can be up to twice those considered globally across the building façade.

The final 'For Construction' detailing will control and reduce the excitation from wind of all facade elements including any external embellishments. Prototype testing will be specified to be undertaken by the façade specialist subcontractors, for areas with potential for wind excitation, to control and remove this risk from the development. Wind induced noise from gaps and perforations in the cladding shall be identified by prototype testing for façade types considered to be at potential risk of wind induced noise. Façade elements will be detailed and separated to prevent wind induced rattling. The stiffness, mass and modes of vibration and the potential for wind induced excitation shall be considered and designed out as part of the final 'For Construction' documentation.

Final fatigue calculations for the cladding and façade elements shall be undertaken prior to the issuance of a Construction Certificate. It is unlikely that the results of these calculations will result in any change to the external appearance of the building.

All other potential sources of noise from facade mechanical elements, motors and operable components shall be considered as part of the 'For Construction' documentation and procurement and included in prototype confirmation.

2.2.5 Earthquake Actions

Earthquake design loading is in accordance with AS1170.4 (Earthquake loads) and AS/NZS1170.0. The following parameters have been adopted for the project. In the final 'For Construction' documentation of the façade the effect from induced deformations of the supporting structure from seismic excitation shall be considered in the design of façade elements. This has been assessed as having a small effect compared with the larger wind movements of the building and the specification of the current joint sizes between façade elements.

Item	**Value**
Building Importance Level	III (Major structures affecting crowds)
Annual Probability of Exceedance	1:1000
Probability Factor	1.3
Site Hazard Factor	0.08
Site Sub-Soil Class	C_e (TBC by geotechnical engineer)
Structural Ductility Factor	2
Structural Performance Factor	0.77

2.2.6 Thermal Actions

Thermal expansion of both façade and cladding materials and support structure has been considered in the design. Adequate movement allowances for thermal contraction and expansion are included in the detailing of all façade systems. The range of temperatures considered for the façade and supporting structure considers construction sequence as well as an ambient temperature range of -10C to +50C. Additional thermal effects from the materiality, conductivity, gloss and colour of the material will be incorporated into the final 'For Construction' documentation.

2.2.7 Imposed Deflections and Movements

The façade has been designed to consider the following imposed deflections and movements:

- wind and seismic induced frame vertical deflections
- column shortening from creep
- horizontal structure differential vertical deflection between floors
- differential rotation along a slab edge between columns
- torsion mode of building excitation
- warping of façade panels.

2.3 FAÇADE WIND MODELLING

The development has been wind tunnel tested to determine building storey shears and loadings to ensure the efficient design of the structure and prediction of the excitation of the overall building.

As there are few external elements and embellishments to the tower, combined with the circular plan of the tower, the design wind pressures are relatively uniform and predictable by the provisions for wind loading in Australian Standards, albeit conservative. Local pressure coefficients at the intersection point between various plan curve profiles have been adopted using the Australian Standard for wind loading. However to reduce the conservative nature of this approach and minimise design loads on the cladding a pressure tap modelling may be undertaken.

Final assessment of the natural vibration, fatigue, rattling and deflection of all external embellishments, prior to final 'For Constriction' design and detailing will be undertaken using experience and recognised published data and practice. Alternatively wind tunnel modelling of the façade using a model with local pressure taps and tubes could be used to reduce the final cladding design wind loads.

Pedestrian comfort wind speed modelling has been undertaken by the project wind engineer to provide guidance and confirmation of a safe pedestrian level wind climate at external locations across the development, as well as identifying the required mitigation control measures which have been incorporated into the design.

2.4 DESIGN LIFE

The building has been designed for a service life of 50 years in accordance with the NCC.

2.5 WARRANTY PERIOD

The warranty period for the façade is expected to be seven years from Practical Completion after negotiation with the project contractor. Surface protection warranties may exceed this and be in the region of 15 years which corresponds to the expected period to first major maintenance for the building façade. Any warranty period and obligation for the façade specialist subcontractor and material suppliers would be contingent on the façade and its elements being cleaned on a regular basis in accordance with the negotiated warranty conditions.

Operable elements as part of the façade could be expected to have a shorter warranty period of one to two years and require programmed maintenance.

2.6 ELEMENT DEFLECTION LIMITS

Element deflection in accordance with individual design codes for each material type have been adopted including for steel, aluminium, glass, timber, stone and concrete.

2.6.1 Deflection Limits (Façade)

With long spans (up to 16m) between façade supports, the total deflections are relatively large. Detailing of the façade connections allows for this as façade deflections in the long span areas have been limited as below:

Façade Type	**Deflection Limits**	
	Short Term	**Long Term**
Lightweight Flexible Facade	Span/800 (20mm)	Span/500 (32mm)
Curtain Walling	Span/1000 (16mm)	Span/800 (20mm)

2.7 PART J COMPLIANCE

Part J compliance for the fabric of the façade glazed and non-glazed areas is required by the NCC. The interaction of window glazing size, material and element thermal and insulation performance with the degree of additional shading from devices is determined during the undertaking of the Part J compliance. The impact of this work is followed through during the detailed design phase to arrive at the final façade thermal performance values and ratio of vision to non-vision areas.

A simple base elevation by elevation Deemed To Satisfy (DTS) analysis is conducted for each conditioned space in accordance with the simple spreadsheet tools provided with the NCC. This base model sets the energy performance required for the building is then refined by JV3 computer modelling of the specific desired façade across the whole building conditioned space. So long as this refined JV3 conditioned space modelling has an overall heating and cooling load demand less than that identified by the simplistic spreadsheet approach then the façade complies thermally.

This JV3 computer thermal modelling is standard for architectural facades where a holistic design is required across a building or conditioned zone.

Areas of non-vision façade have been designed to be fully insulated with 100mm continuous thickness of insulation.

Façade and window framing has been designed as thermally broken to improve the insulation value of the façade as part of the NCC Part J requirements and also to reduce condensation and local discomfort experienced by the building occupants.

NCC Part J compliance outputs inform and identify the following:

- required window vision sizes
- glass performance values for direct solar gain
- glass performance values for thermal insulation
- glass performance values for colour and Visible Light Transmission (VLT)
- angle, size, extent and density of any shading devices.

2.8 THERMAL PERFORMANCE

2.8.1 Heat Load and Thermal Comfort

The heat load transmitted through the façade into the building conditioned space is minimised to meet the DTS provisions of NCC Part J. Additionally JV3 modelling is used to reduce the overall plant requirement for the building.

The design for the façade at the hotel sky lobby incorporates large areas of glass to capitalise on views to the harbour and city which is beyond the simplistic intent of the NCC DTS provisions. As such these areas have been considered as larger conditioned spaces to optimise mechanical design and ensure the comfort of these conditioned spaces.

The proposed clean external façade design for the hotel and apartment areas would be compromised by a simplified DTS thermal analysis approach where individual rooms are serviced by mechanical plant in such a way that every façade location round the tower is designed and commissioned for the worst conditions occurring simultaneously across the floor plate. This approach, while traditional for hotel design, is not adopted on other large plate building such as commercial buildings where flush sleek architecture may be achieved. A holistic collaborative approach between Architect, JV3 modeller, mechanical engineer and façade engineer has been adopted to balance the requirements of all design stakeholders to target and arrive at a fully coordinated, efficient solution which optimises the energy requirement to heat and cool the building.

Thermal comfort for building occupants in general common areas as well as individual habited rooms has been considered utilising thermal breaks in all façade framing as well as insulated glass. Additional block out blinds have also been adopted. The thermal conditions referenced in the NCC have been utilised.

2.8.2 Glazing Selection

Throughout Insulated Glass Units (IGUs) with low emissivity coating to a glass surface contained within the IGU have been adopted at sealed conditioned building areas except where glass support and capture detailing precludes their use.

Glazing performance requirements have been determined with reference to the NCC Part J calculation and all other thermal analysis.

The colour of the glass specified is carefully controlled with reference made to the hue angle and depth of chromaticity accepted in glazed façade elements. Consideration will be made, including physical mock-ups, of any blind behind glazing and the effect the raw glass and coating colour has when viewed externally as well as colour perception behind the glass internally. The acceptable range of glass colour hue and consistency of raw glass batches is identified for monitoring.

The degree of glass heat treatment and quality control has been considered to maintain the desired glazing visual consistency.

External discrete horizontal shading has been considered and refined in location, extent, size and angle as part of the thermal performance analysis. In particular north facing facades can cause high amounts of solar gain for extended periods of the day and benefit from horizontal blades. East and West facing facades typically have high short term thermal loads, and glare, at the morning or late afternoon. South facing facades require clearer glass and less shading to transfer heat into the building during the winter months.

An operable responsive shading device, such as a blind or venetian, are contained in a cavity formed within the facade behind the external glass makeup. Additional block out blinds on the inner face of the façade element provide an additional minor thermal improvement in performance.

2.8.3 Façade Framing Selection

Framing to all windows is thermally broken to improve the overall insulation properties of all glazed areas. Glass capture is achieved from structural silicon to reduce the external exposure of aluminium framing. Additionally joint gaskets are adopted to protect aluminium to the inside of framing elements from external thermal conditions.

Any external shading devices are to be thermally isolated from the main façade framing so as not to transfer thermal and solar heat gain loads to the window frames and into the building conditioned areas.

Cold bridging is typically a concern when outside temperatures drop significantly below the required internal temperatures at higher humidity causing internal condensation. Additionally poorly detailed and under insulated façade non vision areas can result in local occupant discomfort from high or low external temperature loads.

All façade elements are thermally broken, insulated and separated from external shading devices that may collect heat.

Condensation and façade thermal transfer calculations will be undertaken prior to the issuance of a Construction Certificate. It is unlikely that the results of these calculations will result in any change to the external appearance of the building.

2.8.4 Non-Vision Areas

Insulation to be provided and detailed in all non-vision areas of façade at boundaries of each and every conditioned space, walls, roofs and exposed floors. All non-vision areas to be continuously insulated including at slab edges, columns and supporting steel structure.

Insulation selection and material selection will respond to fire and smoke performance and spread.

The selection and detailing of all insulation considers response to moisture and long term durability if located outside the vapour barrier of the façade system.

2.9 ACOUSTIC PERFORMANCE

2.9.1 Acoustic Criteria

Sources of noise have been identified and compared to the required internal acceptable levels. Required noise drops required as identified to be provided by the following means:

- traffic noise to be attenuated by window glass selection, framing metal thickness and density of cladding insulation
- floor to floor noise to be attenuated by metal smoke seals between floors with additional slab edge insulation as required
- flanking noise to be controlled by coordinated external façade and internal wall set-out with mullions and insulation located between internal spaces required to be acoustically separated
- adjacent plant room noise into office spaces to be identified and controlled by either designing the spaces to remove the noise source or in the last case locally thickening glass selections and increasing façade mass and insulation
- in areas of high and hard to control acoustic issues an internal operable jockey sash can be adopted with a 100mm air gap between the external vision glass and the jock sash lite, potentially forming a vented closed cavity for additional thermal control.

2.9.2 Glazing Selection

Glazing thickness considers the required acoustic performance. Potentially all glazing IGUs have a combination of glass thicknesses to control noise transmission. A thicker lite on the external face of a glazing IGU also reduces any risk for distortion within the glazing.

2.9.3 Façade Framing Selection

Framing thickness and detailing contributes to increased acoustic performance. Insulation inside mullions has been avoided.

2.9.4 Non-Vision Areas

Framing thickness and detailing contributes to increased acoustic performance. Insulation inside mullions has been avoided. Acoustic (and thermal) insulation is required behind non vision areas. Commonly non-vision cladding materials which exhibit poor acoustic performance compared to IGU vision glass has been avoided.

2.10 WATERPROOFING

Waterproofing of all façade systems is ensured by pressure equalised principles with a continuous rear air seal protected by a forward vented and drained cavity. Complicated three dimensional joints at the tower between the floor and lift lobby and green zone areas will be carefully detailed in the 'For Construction' documentation especially at façade type junctions and changes in building profile. Local onsite water testing will be undertaken in such areas to confirm on site workmanship.

Detailing of waterproofing systems is consistent with Australian Standards. Rear air seals shall consider workmanship and frame and substrate movement. Liquid applied membranes shall be applied to façade substrates. All internal vented cavities shall drain to the outside.

All operable and opening elements shall provide a continuous pressure gasket system with sufficient frame stiffness to engage and compress all gaskets.

Façade system prototypes shall be tested in accordance with Australian Standards as applicable to the type of façade with test certifications to be provided by the test facility and witnessed by the client's technical representative. This determines if the system design is sufficient from a waterproofing perspective.

Site field water checks shall be undertaken on bench mark installations and at interfaces between façade systems to determine the long term expected performance of the façade workmanship as installed. Interface areas at the floor to lift lobby and green zone where the façade geometry alters as well as the soffit areas will be site water checked to predict long term waterproof performance.

2.11 REFLECTIVITY

Reflectivity of the façade, to both the tower and the podium, has been considered in the choice of façade materials during design. Typically normal specular reflectivity of façade materials is less than 20% and considers the effect of finishes and interior blinds. The proposed glazing for the building will have external reflectivity values below this limit given the process by which heat is rejected by the façade rather than by the simple reflection of the solar direct thermal loading.

Additionally a project solar reflectivity assessment, and associated reporting, has been undertaken by the project consultant CPP which details the potential for solar glare reflectivity impacts on the surrounding roadways in the context of the Sydney DCP 2012.

All non-glazed surfaces are recommended to have low lustre, matte finishes with the normal specular reflectivity coefficient of these elements to be less than 20%. Material selections have been made to meet this recommendation.

The reflectivity assessment by CPP and provided separate to this report made the additional recommendations which have been adopted in the design:

- an upper range of 12% – 15% normal specular reflectivity coefficient (R_{out}) for the Northern section of the Western façade facing Jones Bay Road
- an upper range of 12% – 15% R_{out} for the Southern section of the Western façade facing John Street
- an upper range of 12% – 15% R_{out} for the Virtual Northern façade facing Darling Island Road.

Final glass selection cannot be made until further design developments, including a full energy analysis, has been carried. If a high performance IGU is selected then R_{out} of most make-ups will be closer to 12% than 15%. If an enclosed cavity solution is selected (outer clear monolithic glass – 100 to 150mm air cavity with integral blind – IGU) is selected then R_{out} of most make-ups will be less than 10%.

Additionally concave surfaces of façade have not been adopted in the design given the potential for such configurations to result in concentrated reflections to hazardous levels.

Other risk sources from diffuse solar reflections from the facade will be assessed and mitigated during further stages of the project.

2.11.1 Existing Building Reflectivity

R_{out} of glazing on the existing building provides a good comparison for the proposed glazing R_{out}.

Glazing data was readily available for The Darling but not for the balance of glazing types on older elements of The Star. Reflectivity measurements were taken using an Apogee silicon pyranometer which were corrected for the spectral sensitivity curve within the Optics module of Lawrence Berkeley National Laboratories WINDOW software.

R_{out} results for existing glazing are shown in Figure 2.

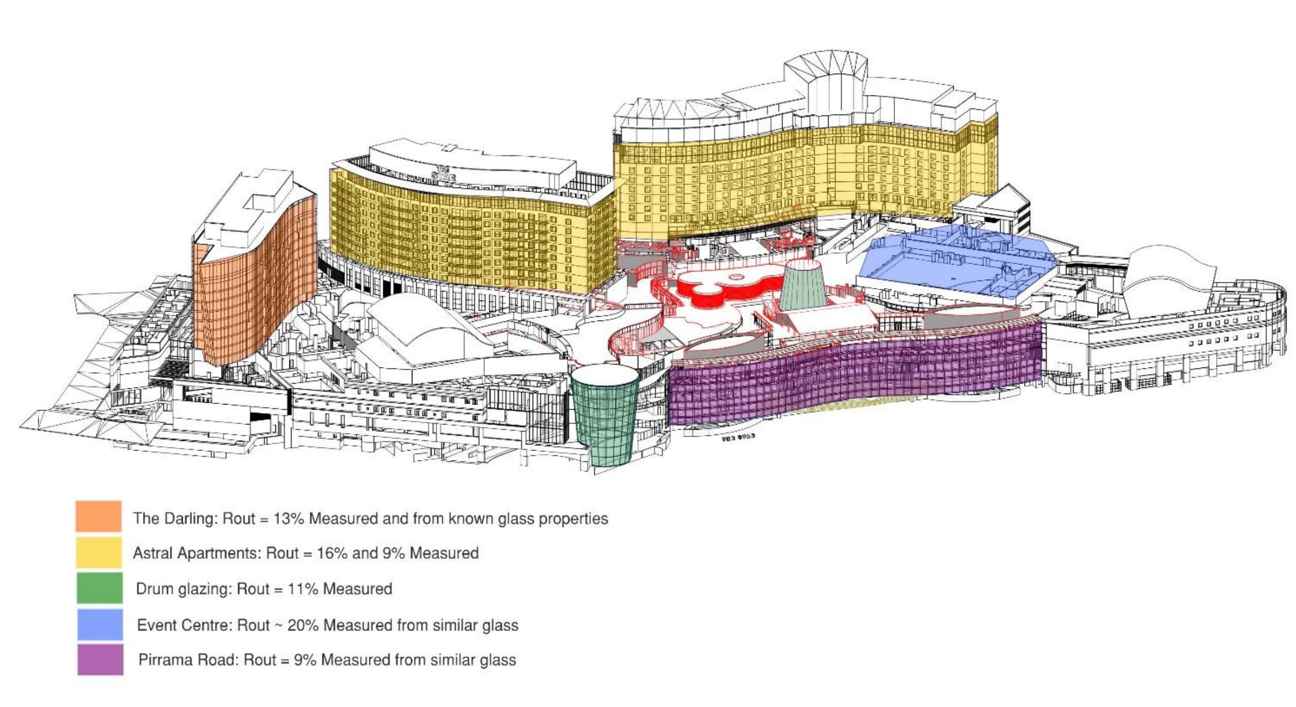

Figure 2

The Event Centre glazing R_{out} is higher than 'expected' as it has a solid frit backing. The frit reduces daylight transmission which is compensated by an increase in reflectance and absorption as *transmission + reflectance + absorption = 1*. Reflectance is split into specular and diffuse components with the specular component being of most concern for glare control. This increase in reflectivity with fritted glass is not well known by the construction industry.

The proposed glazing option with R_{out} of 12% - 15% is comparable to The Darling glazing, is slightly higher than the Drum glazing and is noticeably less than the Event Centre glazing.

The proposed glazing option with R_{out} of less than 10% is slightly less than The Darling glazing, is comparable with the Drum glazing and is noticeably less than the Event Centre glazing.

For both proposed glazing options, the reflected light glare will be similar to existing glare from the Drum glazing and will be less than existing glare off the Event Centre. For the proposed option with R_{out} of less than 10%, the reflected light will be similar to reflected light glare from the existing the Pirrama Road glazing.

The location and orientation of the proposed Tower and Ribbon glazing is different to the existing but the impact of this is covered in the CPP solar reflectivity assessment provided separately to this report and is managed by limiting R_{out} to less than 15%. This can be achieved by both proposed glazing options.

2.12 GLARE

Usability and suitability of internal spaces from a glare perspective shall be undertaken. Potential control measures are tenant operable cavity shading devices or internal operable block-out blinds.

2.13 FIRE CONSIDERATIONS

All façade systems shall be detailed in accordance with the fire consultant report. Smoke seal may be adopted between fore compartments. Combustible materials and materials which promote flame and smoke propagation shall not be used. Any use of composite aluminium panels shall be avoided with stiffened metal panels preferred.

2.14 CORROSION PROTECTION SYSTEMS

Aluminium shall be protected by either external commercial grade powder coating, PVDF or anodising. Bimetallic corrosion shall be avoided by material selection and isolation. Hot dipped galvanised steel in contact with aluminium shall generally be avoided. Fixings and fasteners shall be detailed to prevent bimetallic corrosion. Aluminium rivets shall be carefully specified and details.

2.15 ENVIRONMENTAL IMPACT

From a façade perspective, a major environmental impact of the constructed building comes from the impact of specular reflected light (glare) on surrounding areas. The glare impact on vehicles (cars and the light rail) have been reviewed in the CPP solar reflectivity assessment. This assessment provided a maximum acceptable R_{out} which the proposed glazing options can meet.

TTW measure the R_{out} of the existing glass on the building and found it to be comparable or higher than the proposed glazing.

Based upon the above, the proposed glazing options both minimise the potential environmental impact of glare on the surrounding areas.

3 FAÇADE CLEANING, MAINTENANCE AND ACCESS

For façade maintenance, cleaning and glass replacement to the tower a Building Maintenance Unit (BMU) on Level 63 which retracts into the plant room is proposed. This single BMU would require a reach of 31 metres and need to be progressively pulled in towards, or propped away from, the façade as the two man cradle tracks down the building.

Cycle times would be increased due to the tower building profile. Given the single BMU with telescopic arm cycle times are required to coordinate with the single roof mounted BMU.

A second BMU cradle suspended from Level 59 in the club terrace area should be investigated as part of the cycle time analysis and the spatial planning for a main BMU in the tower roof top plant area.

A cantilever counter balanced BMU cradle is not presently proposed due to the façade profile which also projects outwards from the roof top area.

Ground level facades and low level facades to be cleaned from ground level or using ground based Elevated Work Platforms (EWP). Ground and landscaping to consider access for ground based equipment.

Internal glazed areas including double height glazed walls to be cleaned from ground level or using ground based Elevated Work Platforms (EWP).

Higher levels of façade and between the external offset shading screen may not be able to be accessed by EWP and these areas would require a roof top rail or davit arms to support a one man access cradle for cleaning. Additionally the davit arms would support glass lifting for replacement.

A full analysis of the façade cleaning, maintenance and glass replacement strategy is to be undertaken including cycle time calculation as the façade design develops.

3.1 BUILDING MAINTENANCE UNITS

Single non-tracked luffing, slewing BMU with telescoping jib. Two man powered cradle with props and ties back to façade restraint sockets at every floor with changing outline.

3.2 DAVIT SYSTEMS

For areas of building less than 100m and may assist to improve cleaning times in conjunction with roof top mounted BMU. Potential to locate at green belt or terrace locations. Powered cradle stored at the bottom of any proposed drop.

3.3 SOFFIT MOUNTED RAIL SYSTEMS

Potential limited use in external double height glazed areas. Single powered cradle fixed into soffit track back through openings in the external façade.

3.4 GROUND ACCESSABLE SYSTEMS

Ground based spider systems can reach up top 45 metres.

4 FAÇADE SYSTEMS

4.1 GLASS SELECTION

Glass selection across the project complies with the following principles:

- Insulated Glass Units (IGU) formed from heat strengthened clear or low iron glass, typically with a 12mm thick metal IGU spacer
- Areas of frit to be applied to the inside of IGUs
- Neutral low emissivity coating applied to surface two inside the IGU make up
- Glazing four sided structurally glazed. All glass is in a vertical configuration, that is not sloping, so clamps and external physical restraint required
- Vented cavity behind the IGU with the internal glass selection from clear laminated glass.
- Thermal requirements, flatness, colour, hue and appearance to be developed including the QC limits in the accepted variability and variation of these characteristics
- A physical mockup utilising full glass panel sizes of the project glass with the correct temper for critical façade types and areas
- A reference sample board of 300mm x 300mm samples of all project glazing will be utilised by the design team.

4.2 FAÇADE FRAMING SELECTION

Façade framing selection across the project will comply with the following principles:

- Aluminium framing thermally broken
- Thermal requirements, colour, gloss and protection system to be developed including the QC limits in the accepted variability and variation of these characteristics
- A physical mockup utilising full panels is proposed for critical façade types and areas
- A reference sample board of 300mm long extrusion samples of all project framing and aluminium finishes will be utilised by the design team.

4.3 FAÇADE SYSTEMS – TOWER BASE

Thermally broken and glazed facades and non-vision solid insulated façade as indicated in the Architectural documentation. Flush areas of façade to the community façade with internal operable vertical shading elements.

4.4 FAÇADE SYSTEMS – TOWER

4.4.1 Residential Levels

Window wall system with sealed water proofing sub framing at each slab and soffit. Soffit and slab to be covered with façade cappings with a drained and waterproofed substrate and flashing behind. Cappings designed for building cleaning access and cleaning strategy loading. Thermal insulation required at slab edge and underside of conditioned spaces as well as the clad hob wall.

Potential for high level discrete horizontal external shading blades to the building northern elevations.

Vented cavity internal shading device or interstitial curtain behind external IGU. Additional block out blinds in blind guides and pelmet operated by occupant.

4.4.2 Hotel Levels

Window wall system with sealed water proofing sub framing at each slab and soffit. Soffit and slab to be covered with façade cappings with a drained and waterproofed substrate and flashing behind. Cappings designed for building cleaning access and cleaning strategy loading. Thermal insulation required at slab edge and underside of conditioned spaces. Potential for clad hob wall.

Vented cavity internal shading device or interstitial curtain behind external IGU. Potential for additional block out blinds in blind guides and pelmet operated by occupant.

Hotel sky lobby reception, terrace and lounge levels with double storey areas of façade incorporate double storey façade supported by vertical mullions and internal horizontal beams. The potential for heat and glare issues including the western setting sun behind staff at the reception desk area potentially controlled by an operable external solid and robust blind system outside the vision glass that tracks the sun angle with a late afternoon and evening parking position at the façade to the rear of the reception area is a concept to be developed. External two metre high glazed balustrades and screens with an internal handrail between the metal vertical supporting. Local wind comfort has been assessed with provision for an additional glazed shielding wall in the planted areas at the centre of the terrace area.

At the hotel rooftop plantroom façade types with two and three staged louvres on unitised facade panels have been adopted with internal areas of plantroom to be membraned and drained in conjunction with tested performance storm louvres adequately detailed and structurally supported.

4.5 FAÇADE SYSTEMS – RIBBON

Façade types as shown in the Architectural documentation and designed in accordance with this report with areas of external clad and drained façade systems and external metal cladding supported on an internal metal frame. The cleaning of this curved façade area from ground based systems and internal davit and support arms projecting from operable façade panels.

4.6 FAÇADE SYSTEMS – EXTERNAL BALUSTRADES

External glazed balustrades and screens at tower terrace level to be two metres high with internal handrail to metal vertical posts.

Glazed balustrade loading has been calculated in accordance with AS1170.1. Final 'For Construction' design and detailing of all balustrades acting as a barrier will be for actions as indicated in AS/NZS 1170.1 Table 3.3 considering crowding and furniture. Areas of crowd loading and all barrier classifications are confirmed by the project BCA consultant to ensure compliance.

Glass selection and balustrade type has been determined in accordance with AS1288. Cantilevering monolithic glass balustrades will not be adopted and external laminated frameless cantilevering balustrades do not comply with the deemed to satisfy requirements of the NCC and present an ongoing maintenance liability and degradation risk. As such balustrades with load supporting stanchions and load supporting interlinking handrails have been adopted.

In areas where the requirement for safety glass has been identified, monolithic toughened glass has not been adopted where breakage would result in glass falling onto people below. Laminated glass assemblies are to be used and shall be adequately anchored to provide post breakage capture and stability. Safe breakage patterns and glass post breakage behaviour may be demonstrated by prototype tests undertaken by the specialist façade subcontractor.

5 CONCLUSION

The Star development, including the hotel and residential tower, tower entrances, community centre, podium façades and ribbon roof and cladding elements, have been designed to respond to the environment and context of the site in a positive manner with limited and predictable environmental impacts on the surrounding area relative to what has already been assessed (up to and including Mod 14).

The response of the building to the locations environmental conditions, including solar heat and glare, has been assessed resulting in a design which controls the requirement for heating and cooling in a responsible and compliant manner. The reflectivity of the building has been considered with the resulting material selections made to predictably reduce reflectivity below mandated local requirements. The proposed glazing has also been benchmarked against existing glazing and has found to a similar or lower reflectivites to what is already installed. The local wind climate, at external areas of the development, has been tested and found provide and acceptable wind climate to occupants within the development.

The façade and cladding design for The Star, as documented in the Modification 13 Planning Application, has been undertaken with reference to the design basis and performance requirements provided in this report. This report represents a summary of the response to the many design parameters and performance considerations to which the skin of the building is required to respond. The parameters provided in this report have been developed based on the Architectural design produced by FJMT for The Star Modification 13 as well as advice and coordination with other project consultants with reference to the applicable regulatory framework, design codes and standards.

TTW as the project façade consultant have reviewed the development and Modification 13 Planning Application project documents to ensure compliance with the performance requirements detailed in this report.

All requirements outlined in this report will be included in production documents such as specifications and drawings prior to the issuance of a Construction Certificate.

Additionally TTW, as the project façade consultant, will undertake activities to ensure that ongoing project design development will further enhance the development and is not likely to have any material impact on the design of the development nor potential environmental impacts.