Fire Safety Engineering Strategy Brief
Sydney Showground Main Arena Redevelopment
Royal Agricultural Society of NSW

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Contents

1. Introduction

1.1 The Proposed Development

The Project Application relates to the redevelopment of the Sydney Showground Main Arena (Showground Main Arena) within Sydney Olympic Park to allow for its enhanced use as a multi-purpose cultural and sporting event venue.

In summary, the Major Project Application seeks approval for:

- Reconfiguration of the Showground Main Arena into an oval capable of accommodating an enhanced range of sporting and cultural events in three modes: Show mode; Concert mode; and Sporting mode.
- Increase in seats to accommodate up to 23,000 seated and 2,000 standing, to a total of 25,000 patrons (gross) within new open air and undercover grandstand areas. This includes refurbishment of existing seating and stands as well as the construction of new stands and associated roofs. Whilst there is an increase to seating capacity, there is no increase to the overall current maximum capacity of the Sydney Showground Arena.
- The proposed new stands comprise a north-west stand for Corporate Spectators and Media; a south-east stand for General Admission and Members; and a small north stand for General Admission and Members.
- New on-grade lower seating tier to the eastern half of the Showground Main Arena.
- Installation of a new video board and PA system.
- Increase in size and upgrade of facilities to the existing Level 2 concourse to include new amenities blocks and built-in food and beverage facilities.
- Two new light towers to replace the two existing eastern end light towers.
- New retractable perimeter fencing on the southern and western sides of the grounds.
- New entry structures and egress gates on various perimeter points of the ground.
- New small grassed seating ‘hill’ to the far east of the seating tier underneath the scoreboard.
- New pitch access vomitory to the northern side of the field.
- A ‘green wall’ – a vegetated screen to the outer sides of all three new stands.
- Minor internal refurbishment works to existing areas of facility.

The basis of the design of the proposed redeveloped Showground Main Arena has been to build on the success of the existing venue and enhance its function as multi-purpose, boutique oval based stadium. Whilst the proposal entails expanding the facility to create up to 25,000 (seated and standing) person capacities, there is no increase to the overall current maximum capacity of the Sydney Showground Arena taking into account the standing capacities of the facility.

The proposal entails utilising where possible, the existing infrastructure of the Showground Main Arena and will be capable of enhancing the range of sporting and cultural events including AFL matches which dictate the reconfiguration of the arena surface, as well as enhancing the Showground Main Arena event opportunities during the Royal Easter Show. Architecturally, the design has been the subject of the SOPA Design Review Panel and incorporates an important underlying theme of retaining the “agricultural soul” of the Showground Main Arena, reflecting its cultural and historical association with the Royal Agricultural Society.
The overall redevelopment of the Showground Main Arena will be undertaken within three phases:

- Early works that are to be the subject of a separate Part 4 Development Application (DA). The early works package will entail demolition, excavation, deconstruction of lighting towers, site set up and services deconstruction as illustrated in the submitted demolition plan contained within a Construction Management Plan under ***Appendix B***. The consent authority for the Part 4 DA is SOPA. These works aim to occur prior to the proposed redevelopment that is sought under the Project Application.

- At this point in time, it is proposed to construct all redevelopment works associated with this Part 3A application in two stages. However, Stage 1 will be built using one of two options for the south-east stand, depending on the final allocation of the project budget. For clarity, these stages are known as Stage 1 and Stage 1A.

- Stage 1 of the Part 3A works will reflect the existing budget commitments of $60 million and includes the majority of the above works but with the following changes:

  – The new south-east stand would consist of interim, demountable scaffold seating and will not be roofed;

  – The new north stand would consist of interim, demountable scaffold seating and will not be roofed;

  – The grassed mound to the eastern end would not be built in this stage.

- As an alternative option to Stage 1, in the event that additional funding becomes available, Stage 1a of the Part 3A works will be built. In broad terms, the work is similar to that proposed for Stage 1 with the following exceptions:

  – The new south-east stand will be constructed in its final form using a combination concrete and steel structure. The stand will not be roofed.

  – The new north stand will be constructed in its final form using a combination concrete and steel structure. The stand will not be roofed.

  – The grassed mound to the eastern end will be built in this stage.

- Stage 2 of the Part 3A works will be undertaken upon budget commitments of up to total budget of $73 million and relates to the total project described above, including that the permanent seats to the south-east and north stands and associated roofs will be constructed.

1.2 Fire Safety Engineering Strategy Brief

Aurecon have been engaged to provide the fire safety engineering design for the Sydney Showground Main Arena Redevelopment. The Arena is intended to be used for AFL, NRL, cricket, baseball, concerts and hosting the Royal Easter Show.

The purpose of this document is to outline the fire engineering strategy and proposed methodology which will be employed.

The proposed alterations to the existing back of house areas do not represent more than 50 % of the original volume of the building and as such we consider that there is no obligation to upgrade existing fire safety systems to current standards. The current fire engineering strategy and installed fire safety systems will be maintained to the standards to which they were originally designed.

New building works will be constructed to the BCA 2010 and current standards.

The Arena design is expected to have several departures from the DtS provisions of the BCA relating to egress capacities and lengths in particular which will be addressed using guidance from the 'Guide to Safety at Sports Grounds', commonly known as the 'Green Guide' and will form the basis of the fire engineering strategy and design.

The Fire Engineering Brief (FEB) and Fire Safety Engineering Report (FSER) will be developed in accordance with the methodology outlined in the International Fire Engineering Guidelines (IFEG) (ABCB 2005) while being cognisant of practices and reviews procedures generally accepted in the building design, construction, and fire protection engineering communities.

2. Project design team and relevant stakeholders

2.1 General

The stakeholders listed below will be involved in the development of the FEB and fire safety engineering assessment including:

Table 2-1: Relevant stakeholders and contacts

Role	Organisation	Contact
Client	Royal Agricultural Society of NSW	Peter King
Project Manager	APP Corporation Pty Ltd	Ron Aquilina
Architect	Populous	Warwick Chalmers
PCA	McKenzie Group Consulting	Stephen Natilli
Advisory Agency	NSW Fire Brigade	Benjamin Hughes-Brown
Project Principal	Aurecon	George Reid
Fire Safety Engineer	Aurecon	Marcus Le Quesne
Principal Fire Safety Engineer	Aurecon	Neno Ković

3. General objectives

3.1 Building regulatory objectives

According to the Fire Engineering Guidelines (FCRC 1996)[1], the objectives of the Building Code of Australia are to protect:

- Life safety of occupants – the occupants must be able to leave the building (or remain in a safe refuge) without being subjected to hazardous or untenable conditions
- Adjacent buildings – structures must not collapse onto adjacent property, and fire spread by radiation should not occur
- Life safety of fire fighters – fire fighters must be given a reasonable time to rescue any remaining occupants before hazardous conditions or building collapse occurs

The assertion that property protection is not an explicit objective of the BCA is supported by the following quotation from Agenda Item 8 ("Life Safety versus Property Protection") at the ABCB National Technical Summit 2000:

"The BCA DTS fire safety provisions should only address requirements that provide:

- *safe egress*
- *resistance of the structure to failure and fire spread to enable safe egress*
- *prevention of fire spread to adjoining structures and properties*

AUBRCC (Australian Uniform Building Regulation Co-ordinating Council) concluded that if meeting these objectives results in achieving a degree of property protection then this is considered to be incidental to the overall aim of the BCA. These principles underpinned BCA90 and were carried through into BCA96. The issue of property (asset) protection in terms of protection of a building fabric and its contents should not be considered as a primary goal of the BCA. However, a clear statement was never made in the BCA outlining this intention."

3.2 Non-regulatory objectives

3.2.1 Client risk management objectives

The Client objective is that the design is to comply with the Performance Requirements of the BCA. The Client has not indicated that they require consideration of any other objectives for the fire safety design. Hence, specific protection of the building fabric and contents, minimisation of business interruption, environmental protection and any other issues that are not requirements of the BCA are not being considered in this report. The Client has not advised us that this building is required to fulfil a special purpose in the community.

3.2.2 Fire brigade objectives

The Fire Brigades Act 1989 states that the Fire Brigade should protect life and property. The Fire Brigades Act and the Environmental Planning and Assessment Act 1979 sit parallel within the legislative hierarchy; however the Fire Brigades Act does not form part of achieving compliance with the Environmental Planning and Assessment Act or Regulation.

Fire brigade safety during operations is considered to be primarily achieved through the fire brigade operational procedures. A building design is required to consider "fire brigade intervention" when formulating an Alternative Solution and when the term is referenced within the BCA's Performance Requirements.

[1] The first revision of, and predecessor to, the IFEG

The fire safety design and systems to facilitate fire brigade intervention, as required by the BCA, will be provided. However, as part of this fire safety strategy, no advantage will be taken of fire brigade intervention in assessing the safety of occupants. The fire safety design will contain an acceptable and appropriate safety margin, and sufficient redundancy, without relying on the intervention of the fire brigade. This is considered a conservative approach.

4. Regulatory framework

The Building Code of Australia 2010 is a hierarchal document with 'Objectives', 'Functional Statements' and 'Performance Requirements' for each of its sections. This is described in the following extract from the BCA:

Figure 4-1: BCA structure

4.1 Compliance with the BCA

From Figure 4-1 above it can be seen that the top two levels of the hierarchy are informative only, and are included in the BCA to provide an aid to interpreting the content and intent of the Performance Requirements and the Deemed-to-Satisfy Provisions. Compliance with the BCA is achieved by satisfying the Performance Requirements.

BCA Clause A0.5 specifies that Compliance with the Performance Requirements can only be achieved by–

a) Complying with Deemed-to-Satisfy Provisions; or
b) Formulating an Alternative Solution which–
   i) Complies with the Performance Requirements; or
   ii) Is shown to be at least equivalent to the Deemed-to-Satisfy Provisions; or
c) A combination of (a) and (b).

BCA clause A0.9 provides the following assessment methods to determine that a building solution complies with the BCA performance requirements:

a) Evidence to support that the use of a material, form of construction or design meets a Performance Requirement or a Deemed-to-Satisfy Provision.
b) Verification Methods such as —
   i) The Verification Methods in the BCA; or
   ii) Such other Verification Methods as the appropriate authority accepts for determining compliance with the Performance Requirements.
c) Comparison with the Deemed-to-Satisfy Provisions.
d) Expert Judgement.

BCA clause A0.10 states that in order to comply with the relevant provisions of the BCA the following method must be used to determine the Performance Requirement or Performance Requirements relevant to the Alternative Solution:

a) Identify the relevant Deemed-to-Satisfy Provision of each Section or Part that is to be the subject of the Alternative Solution.
b) Identify the Performance Requirements from the same Sections or Parts that are relevant to the identified Deemed-to-Satisfy Provisions.
c) Identify Performance Requirements from other Sections and Parts that are relevant to any aspects of the Alternative Solution proposed or that are affected by the application of the Deemed-to-Satisfy Provisions, that are the subject of the Alternative Solution.

5. Fire Safety Strategy

5.1 Fire Safety Strategy

The fire safety engineering scope will include a fully performance based fire safety design in terms of egress provisions and other identified non-compliances cognisant of providing safe passage to occupants from the building in line with international standards and codes such that the Performance Requirements of the BCA are satisfied.

Where refurbishment works are occurring to existing back of house areas, fire safety systems shall be maintained to the standards to which they were installed. New stands to the north eastern half of the arena shall be designed to the BCA 2010 and this report.

All stands are open to the atmosphere and while some are roofed (extent of roofing to be confirmed), it is expected that the design will not allow smoke to build up and endanger occupants in the stands. As such it is likely that there will be unlimited tenability available for occupants not in the immediate vicinity of the fire. As per the recommendations of the Green Guide however (see Section 9.4), the target time for egress from the building to a place of safety will be 8 minutes.

5.2 Proposed Egress Strategy

The existing and proposed population levels in the Arena are as follows:

Table 5-1: Arena population levels

	Population
Showground Mode	
Existing seats	13,570
Existing maximum capacity	18,000
Proposed seats	20,200
Proposed maximum capacity	22,200
Concert Mode	
Existing seats	10,198
Existing maximum capacity	30,021
Proposed seats	10,198
Proposed maximum capacity	30,021
Sporting Mode	
Existing seats	14,026
Existing maximum capacity	17,000
Proposed seats	23,000(min)
Proposed maximum capacity	25,000(max)

Preliminary analysis and drawings by Populous utilise egress capacities based on the recommendations of the Green Guide and are presented in Appendix A. This design has the majority of occupants heading up or down the seating tiers to egress the bowl at Level 2 which minimises the need for further changes in level and will maximise the rate of egress from the concourse which is generally on grade. There are six major exits from the concourse area distributed around the Arena.

5.3 Reporting

An FEB is part of the fire engineering design process recommended by the IFEG, The FEB is the first part of a two-step process, and establishes the basis upon which the future fire engineering analysis and reporting is undertaken. The second part of the process will be development of a Fire Engineering Report (FER), which will provide a summary of the evaluation and results and will draw conclusions on Building Code compliance.

The FEB defines the scope of work for the fire safety engineering assessment. Its purpose is to set down the basis, as agreed by the stakeholders, on which the fire safety engineering assessment will be undertaken.

Following acceptance of the FEB by the design team and stakeholders, this will form the basis for the fire safety engineering assessment and the development of the Fire Safety Engineering Report (FSER). The FSER will provide assessment for compliance with the Building Code of Australia (BCA).

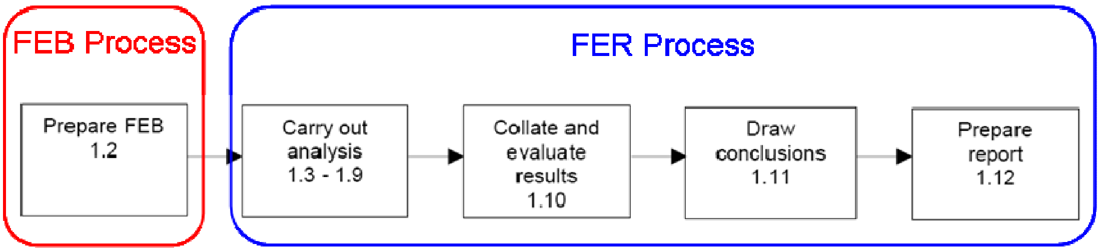


Figure 5-1: The fire engineering design process reproduced from the IFEG (ABCB 2005)

It will be shown in the final Fire Engineering Assessment report that each of the Alternative Solutions will satisfy the Performance Requirements of the BCA and that sufficient mitigation measures have been proposed during design and operations to reduce the risks associated with the Alternative Solutions to acceptable levels.

6. Assumptions and limitations

6.1 Assumptions

The assumptions made in this report for the building development are provided below. Any alterations to the design that result in the assumptions becoming invalid should result in a new fire safety design. The following assumptions have been made in this report:

- All fire safety systems and management strategies are to be fully maintained in accordance with this report and relevant Australian Standards.
- All other components of the building not addressed within this document will be installed to the requirements of the DTS provisions of the BCA 2010 or remain as required within the existing building permit conditions/design at the time of construction.
- The fuel load and configuration will result in a rate of fire growth that can be adequately predicted
- Fire Safety Management and Emergency Control Organisation to AS 3745.
- The building owner and/or operator has been made aware that the Alternative Solutions sought may affect their ability in obtaining insurance cover for their building. This issue is assumed to be addressed between the building owner and/or operator with their insurer.
- It is assumed that the design drawings and specifications upon which the fire engineering assessment will be based are accurate with respect to the final as built condition of the facility.
- Any significant changes to the design drawings and/or specifications will be referred to the relevant building surveyor and/or fire engineer for review prior to acceptance.
- It is assumed that all relevant information necessary to perform and affecting the fire engineering assessment will be supplied for review.
- Only one fire will occur at a time. It is considered that the BCA DTS provisions only consider a single fire. This is evident by prescribing alternative exits and fire sprinkler systems being designed for only one area of operation.
- Occupants will become aware of the fire through fire cues from the alarm system or visually, respond to the cue, cope with the cue and attempt to avoid the fire, as intended by the BCA for safe evacuation.
- Occupants and staff do not engage in major fire fighting activities. Evacuation of occupants will be the main consideration of staff
- All corridors, exit paths and egress points are maintained clear of obstructions that may prevent safe evacuation.
- The positive effect of fire brigade operations on controlling the fire and performing search and rescue will not be taken into account in the analysis. This is done to simplify the analysis, given that the response and set up time of the fire brigade may vary considerably and is conservative.
- The assessment of pedestrian movements and egress times can be accurately analysed using the STEPS pedestrian movement model.
- The analysis of fire growth and subsequent smoke spread can be accurately carried out using the Computational Fluid Dynamics programme Fire Dynamics Simulator (Version 5), developed by the National Institute for Standards and Technology (NIST).

6.2 Limitations

The following limitations apply to the fire safety analysis to be performed. Any change in the limitations may alter the final design solution and hence should be referred to a suitably qualified fire engineer for review prior to altering the design.

- Property protection other than explicitly considered by the BCA is outside this scope. If further property protection requirements are desired this information shall be provided to the fire engineer.
- Environmental considerations arising from a fire or the effect of fire fighting operations on the surrounding neighbourhood are outside this scope

- The DTS provisions of the BCA are to be addressed by the relevant building surveyor and reported in separate documentation where appropriate. The fire engineering design will be based on their assessment and does not address non-compliances to the DTS provisions that are not detailed in their report or are outside of the scope of this assessment.
- If the development is to change in the future the buildings may have to be re-classified and re-assessed.
- The assessment is limited to an analysis of the level of compliance of the proposed design to the Performance Requirements of the BCA or the adequacy with which those provisions satisfy the Performance Requirements.
- The concepts outlined in this report assume a complete and operational building, and do not address protection of the building during construction, renovation or demolition.
- Any change in building, occupant or fuel conditions outside of those considered by this report, or any deviation in the implementation of the fire strategy outlined in this report, may result in outcomes not anticipated by the strategy, and should be reviewed.
- Environmental and community protection except that inherently achieved by compliance with the Building regulatory including Development approval and compliance with the BCA is beyond the scope of this report.
- This report does not address OH&S issues with respect to the use of various materials, furnishings and construction methods except those related to occupant and fire brigade safety during an emergency to a level required by the Performance Requirements of the BCA as indicated by the Guide to the BCA.
- Control of the fuel load within the common areas and corridors such that no permanent fuel load is to be stored to be placed on Essential Services List and audited yearly.

6.3 Arson

With respect to arson and deliberate negative human intervention on a fires development and response of the fire safety systems the following assumptions and limitations are considered to apply to the fire safety strategy and building design:

- The analysis is limited by excluding an analysis of fire scenarios resulting from deliberate multiple ignition sources. It is considered that given the below assumptions and limitations that multiple ignitions are unlikely to occur.
- It is considered that the fire scenarios and fire growth rates developed as part of the fire strategy will be applicable to arson fire scenarios resulting in one seat of fire and associated with the ignition of the fuel load items normally contained within the facility.
- Based on past fire investigation and testing experience it is assumed that if a liquid hydrocarbon accelerant is used in ignition of a fire, after rapid initial growth associated with burning of the liquid accelerant, the continued fire growth rate would be that for the normal contents within the facility. Accordingly, for design purposes the chosen peak heat release rates and fire growth rates are considered to be applicable.
- It is assumed that if a liquid hydrocarbon accelerant is used in the fires ignition that it is limited to those readily available to the general public. Scenarios involving aviation fuel or the like are not considered.
- It is assumed that during normal operating hours that any person(s) involved in deliberate ignition of a fire will not be able to significantly re-arrange or increase the level of combustible contents or distribute significant quantities of liquid hydrocarbon accelerant, i.e. greater than a small container, without being observed.
- It is assumed that the risk of a person(s) deliberately igniting a fire within the subject facility is no greater than for a facility complying with the DtS provisions of the BCA.
- It is assumed that the fire safety systems within the facility will not be de-activated during any attempt to deliberately ignite a fire and that if they are in the process of de-activating the systems; the systems will raise an alarm or be observed. However, the effects of loss of one of the fire safety systems are addressed as part of the sensitivity and redundancy analysis.

7. Dominant occupant characteristics

7.1 Population

The building is predominately a mixture of public assembly areas and back of house areas comprising offices, player and official support and other ancillary spaces. It is considered that occupants within the building will be alert and reasonably mobile. Any staff or visitors who are disabled are assumed to be assisted by staff members.

All occupants are expected to have a level of understanding where they can recognise an emergency situation. The occupants are expected to have the ability to take and implement decisions independently and the potential emergency behaviour is to be rational and constructive to the emergency situation.

Occupants are expected to be familiar with the primary access and egress routes from the building.

The design occupant groups have been determined using the process described in the below table for each area.

Table 7-1: Occupant characteristics

Process	Outcome
Step 1 For the occupancy being assessed, identify occupants who share major traits and attributes, and develop occupant groups	The building contains two main areas; public viewing stands and back of house Accordingly, three main occupant groups are considered to exist, • Visitors • Staff • Players / officials
Step 2 Describe and name each occupant group.	• Transient – visitors and to a slightly less degree players / officials. Unfamiliar with the building layout. Expected to follow instructions from staff • Permanent – staff. Staff will receive training and have a warden system set up with floor wardens and chief wardens consisting of security and facility management staff.
Step 3 Identify building detection and warning	Detection design to be determined. Likely to consist of smoke detection in back of house areas and visual notification in stands
Step 4 For each scenario to be investigated on the assessment, identify the occupant group most likely to play a major role in detection	Design occupant group for detection: • Staff – back of house and stands • Players / officials – fields and associated support • Visitors – stands
Step 5 For each scenario to be investigated on the assessment, identify the occupant group most likely to play a major role in pre-movement	Design occupant group for pre-movement: • Staff - all areas

Step 6 For each scenario to be investigated on the assessment, identify the occupant group most likely to play a major role in movement based on physical and mental attributes and familiarity with the building.	Design occupant group for movement: • Staff – back of house and stands • Players / officials – fields and associated support • Visitors – stands

7.2 State and physical attributes

The general public make up the majority of occupants in the building. The occupants are expected to vary from ambulant to mobility impaired, male and female, young to elderly, but are assumed to be generally transient, alert and awake. In general it is expected that the population in the building will be similar to a sample of the general public.

7.3 Level of assistance required

It is expected that some occupants will require assistance to evacuate in the event of an emergency. This is likely to be provided by staff or other occupants. Staff numbers are expected to be high during an event providing assistance to occupants where required and guiding the evacuation.

7.4 Emergency training

Security staff and fire wardens will be trained in emergency procedures and have good knowledge of the building such that they can provide assistance during an evacuation. Training may involve initial attack on a fire when safe to do so using fire extinguishers and fire hose reels. Occupants will be instructed on the actions necessary on the activation of the emergency warning and intercommunication system.

7.5 Fire brigade intervention

While the fire brigade will act to control the fire and will be available to assist evacuation through search and rescue of occupants, this action is not incorporated in the analysis of occupant evacuation in this report. The fire safety assessment is therefore conservative in this regard.

8. Hazards and preventative protective measures

8.1 Hazards

In determining the likely fire hazards, the following factors should be considered:

General Hazards

- Mixed use, a variety of ignition and fuel sources

Ignition sources

- Smoking material (whether prohibited or not)
- Heating equipment
- Other electrical and electronic equipment
- Plant
- Arson
- Vandalism

Fuel sources

- Rubbish
- Furniture (variety of uses)
- Furnishings and surface finishes
- Other electrical wiring
- Plant – generators, transformers, etc
- Introduced fuels (arson)

8.2 Preventative and protective measures

Hazards, that have been identified above are able to be reduced or removed by preventive and protective measures.

8.2.1 Preventative measures

Preventative measures are typically 'management in use' methods and include required measures to minimise the likelihood of fire initiation.

- No smoking policy within the building
- Restricted public access to certain areas
- Electrical safety equipment
- Regular emptying of rubbish bins
- Management of combustibles including housekeeping measures
- Ongoing fire drills and training of staff including fire wardens. Training shall include first aid firefighting techniques.
- Commissioning and integrated function testing of all fire safety and protection systems including interfaces to ensure proper function must be undertaken.
- All essential services are to be maintained and tested in accordance with the requirements of relevant building regulations and relevant Australian Standards.
- All essential fire safety systems must be the subject of regular periodic maintenance by reputable contractors. The maintenance must follow the Australian Standards for those systems, including periodic inspection as required by the relevant codes, Australian standards and the Building Code of Australia (BCA). Where services are modified as part of an alternative solution, these will be included in the maintenance and annual certification.

8.2.2 Protective measures

Protective measures fall within the jurisdiction of the BCA and may include the following installed systems.

- Conventional point style smoke detection and/or aspirating systems
- Heat detection system
- Fire hydrant system
- Fire hose reels
- Portable fire extinguishers
- Emergency lighting
- Exit signs and direction signs
- Standby power system to operate required safety systems in event of main power failure
- Fire resistance levels in accordance with Part C of the BCA
- Appointment and regular training of Fire Wardens and regular evacuation drills for all staff
- Automatic sprinkler system

9. Approaches and methods of analysis

9.1 Approach

Fire engineering design approaches are:

- Comparative or Absolute
- Qualitative or Quantitative
- Deterministic or Probabilistic

An expanded description of these approaches may be found within the IFEG (ABCB 2005). Note that deterministic and probabilistic approaches can only be applied to quantitative analysis. A useful representation of the differences between a comparative versus absolute approach and a probabilistic versus deterministic approach is provided Table 9-1 below. This table is reproduced from the UK Fire Engineering Guidelines PD7974-0 (BSI 2002). The UK Guidelines are very similar in scope and content to the IFEG.

Table 9-1: Typical examples of acceptance criteria (reproduced from PD7974-0)

		Fire safety objectives	
		Deterministic	**Probabilistic**
Analysis method	**Comparative**	Time available for escape is at least equal to that in an equivalent code compliant building	Level of risk of life equivalent to a code compliant building
	Absolute	The time available for escape exceeds the time to untenable conditions	Expected number of casualties per year

Definitions of these approaches, abridged form the IFEG (ABCB 2005) are included below in Table 9-2. In justifying the compliance issues outlined in Section 10, the approach varies according to the specific compliance issue.

Table 9-2: Summary of analysis approach

Approach	Definition (abridged from IFEG)
Qualitative	Qualitative analysis may be agreed during the FEB process to be sufficient for the consideration of minor stand-alone compliance issues. The basis (logic) on which this approach is used should be documented with appropriate references.
Quantitative	The complexity of the compliance issues will often require a quantitative approach. This entails the use of one or more of the many analysis methods available The quantitative methods will often be supported by additional qualitative arguments.
Comparative	A comparative approach aims to determine whether the alternative solution is equivalent to (or better than) the deemed-to-satisfy or prescriptive design. The comparative approach is often referred to as an “equivalence” approach.
Absolute	In an absolute approach, results of the analysis are matched directly against the performance requirements of the BCA, using agreed acceptance criteria
Deterministic	Deterministic analyses are based on physical relationships derived from scientific theories and empirical results. Characteristically, for a given set of initial boundary conditions, a deterministic methodology will always produce the same outcome. They do not, however, indicate the probability of that outcome being realized.
Probabilistic	Probabilistic approaches use a variety of risk based methodologies. These methods generally assign reliabilities to the performance of the various fire protection measures and assign frequencies of occurrence of events. They may analyse and combine several different scenarios as part of a complete fire engineering evaluation of a building design. This use of multiple scenarios and their combination through probabilistic techniques is the key feature of some of the methods.

9.2 Methods of analysis

The design building is expected to contain a number of departures from BCA DtS provisions and will contain a large number of people. As such the fire engineering strategy is to use a holistic approach to maintain an appropriate level of life safety within the building. This will primarily encompass a quantitative deterministic ASET – RSET approach for evaluating the time until untenable conditions in the building compared with the time required for evacuation.

The ASET – RSET analysis will be supported by qualitative discussion and a hazard and risk analysis considering the most likely and highest consequence potential fire events. The Arena design will be considered in line with comparison to the DtS provisions of the BCA and with international standards and codes.

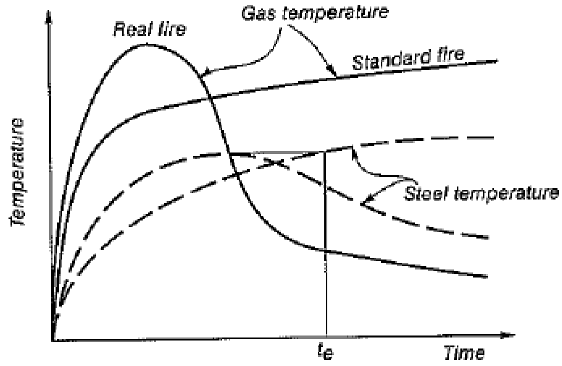
The performance of the structure to a potential fire will be assessed using the method of equivalent fire severity which is a deterministic quantitative analysis used to consider where fire ratings are reduced compared to the requirements of the BCA.

9.3 Reduced Fire Rating

The *equivalent fire severity* is calculated using the Eurocode formula (EC1 2002). It must be stressed that this is an equivalent time and does not relate to real times. The time-temperature relationship in real fires is different to the 'standard' fire temperature-time curve which is based on furnace tests from the 1930's. The observed differences induced the idea of the time-equivalent concept, or the 'equivalent structural fire severity'. This time-equivalence formula gives the equivalent structural fire severity for an enclosure based on fuel load, ventilation conditions and lining materials.

The equivalent structural fire severity is the time of exposure to the standard fire resistance test which is assumed to result in the same thermal impact as a complete burnout of the compartment in a real fire (assuming sprinkler failure). It is an empirical correlation derived from tests and calculations of the temperature of protected steel beams exposed to a range of real fires. Assemblies provided with a fire resistance equal to or greater than the equivalent structural fire severity are generally expected to be able to withstand a complete burnout of the compartment. The relation can be calculated if the fire load density and the ventilation conditions of the fire compartment are known.

This concept is demonstrated in the following figures, reproduced from Buchanan (2001b).



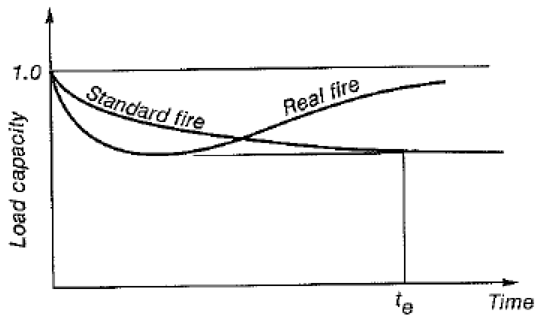


Figure 9-1: Equivalent fire severity idealisation on an (a) temperature basis, and (b) load capacity basis

From the Eurocode (EC1 2002) the equivalent fire severity t_e (min) is described by the following equations:

Equation 1

$$t_e = e \cdot k_b \cdot w_f$$

Where:

t_e = equivalent time of fire exposure to the standard test (min)

e = fire load density based on the fuel averaged over the floor area (MJ/m^2)

k_b = conversion factor that relates to the thermal properties of the enclosure

w_f = ventilation factor that allows for the size of the opening, given by Equation 2.

Equation 2

$$w_f = \left(\frac{6}{H}\right)^{0.3}\left[0.62 + \frac{90(0.4-\alpha_v)^4}{1+b_v\alpha_h}\right] > 0.5$$

Where:

$\alpha_v = A_v / A_f$ and $0.025 \leq \alpha_v \leq 0.25$

$\alpha_h = A_h / A_f$ and $\alpha_h \leq 0.2$

$b_v = 12.5 \cdot \left(1 + 10\alpha_v - \alpha_v^2\right)$

$A_f =$ floor area of the enclosure [m^2]

$A_v =$ area of vertical window and door opening [m^2]

$A_h =$ area of horizontal openings in the roof [m^2]

$H =$ the height of the enclosure [m]

The Eurocode (EC1 2002) is also used to determine the design value of the fire load which is based on the probabilistic risk assessment of the fire safety systems. The design value of the fire load ($q_{f,d}$) is defined by Equation 3:

Equation 3

$$q_{f,d} = q_{f,k} \times m \times \delta_{q1} \times \delta_{q2} \times \delta_n$$

Where:

$q_{f,k}$ = the characteristic fire load density per unit floor area [MJ/m^2]

m = the combustion factor

δ_{q1} = a factor taking into account the fire activation risk due to the size of the compartment

δ_{q2} = a factor taking into account the fire activation risk due to the type of occupancy

$\delta_n = \prod_{i=1}^{10} \delta_{ni}$ = a factor taking into account the different active fire fighting measures (see Table below)

Table 9-3: Factors δ_{ni} (reproduced from EC1 2002)

δ_{ni} Function of Active Fire Fighting Measures									
Automatic Fire Suppression		Automatic Fire Detection			Manual Fire Suppression				
Automatic Water Extinguishing System	Independent Water Supplies 0 / 1 / 2	Automatic fire Detection & Alarm by Heat	Automatic fire Detection & Alarm by Smoke	Automatic Alarm Transmission to Fire Brigade	Work Fire Brigade	Off Site Fire Brigade	Safe Access Routes	Fire Fighting Devices	Smoke Exhaust System
δ_{n1}	δ_{n2}	δ_{n3}	δ_{n4}	δ_{n5}	δ_{n6}	δ_{n7}	δ_{n8}	δ_{n9}	δ_{n10}
0,61	1,0 / 0,87 / 0,7	0,87 or 0,73		0,87	0,61 or 0,78		0,9 or 1 or 1,5	1,0 or 1,5	1,0 or 1,5

In order to determine the fire load the probabilistic fire load density curve will be utilised.

The Fire Engineering Guidelines 2000 indicate the following fire load densities:

Table 9-4: Fire load energy densities described by occupancy type

Densities in Megajoules per square metre				
Occupancy	**Average** (MJ m^{-2})	**Fractile *** 80%	90%	95%
Dwelling	780	870	920	970
Hospital	230	350	440	520
Hospital storage	2000	3000	3700	4400
Hotel bedroom	310	400	460	510
Offices	420	570	670	760
Shops	600	900	1100	1300
Manufacturing	300	470	590	720
Manufacturing and Storage*<150kg m^{-2}	1180	1800	2240	2690
Libraries	1500	2250	2550	---
Schools	285	360	410	450

The equivalent fire severity assessment will determine the required structural fire resistance for the building elements to survive fire burnout based on the above information.

9.4 Required safe egress time (RSET)

9.4.1 2008 Green Guide

For emergency evacuation modes, the intended target for evacuation is as per the 2008 Guide to Safety at Sports Grounds (Green Guide, 5th Edition). The guide is intended for application to sporting venues and is recognised as an authority on large crowd venues generally. It should be noted that there is a defined difference between “Egress” and “Evacuation”, the former being the mode of movement by patrons in a non emergency situation such as the end of a game, match or performance. The STEPS model (discussed below) will be used to simulate evacuation, however, as explained below, the time aims for both egress and evacuation for this facility are the same.

9.4.2 Egress

For egress time the Green Guide states:

"The egress time is the total time in which all spectators can, in normal conditions, leave an area of viewing accommodation and enter into a free flowing exit system. It does not include the time taken to negotiate the entire exit route"

"The normal maximum egress time for sports grounds is eight minutes".

9.4.3 Evacuation

For evacuation the Green Guide states:

"The emergency evacuation time is a calculation which, together with the rate of passage, is used to determine the capacity of the emergency exit system from the viewing accommodation to a place of safety or reasonable safety, in the event of an emergency"

"The maximum emergency evacuation time for sports grounds varies between two and a half minutes and eight minutes."

This time is that taken to travel "from the varying accommodation to a place of safety".

9.4.4 Place of Safety

The Green Guide defines a place of safety as "A place, away from the building, in which people are at no immediate danger from the effects of fire." Accepted industry understanding of the definition of "place of safety" is an area free from the effect of smoke and fire for a period of not less than 30 minutes.

In reference to the design building a "place of safety" is considered to be reached when occupants leave the concourse area through one of the six available exits shown.

9.4.5 Fire Risk

The Green Guide also expands upon categories of risk to determine the variance of time allowed for evacuation. For a low fire risk, the Green guide states

"A low fire risk seated or standing area at a sports ground is likely to be one where:
a) the risk of a fire occurring is low, and
b) in the unlikely event of a fire, the potential for the fire, heat or smoke generated by it, to spread, is negligible,and
c) there is a minimal risk to life.

Such structures might include open terraces and stands constructed of non-combustible materials with fully protected catering outlets.

For low risk seated and standing areas, the emergency evacuation time for all spectators to reach a place of safety or reasonable safety should be no more than eight minutes."

Consistent with definition above, it is considered that the building falls into the 'low fire risk' category as the potential for harm from fire, heat or smoke is negligible due to the open nature of the stands and lack of significant fire load in these areas.

9.4.6 Target Time

Taking into account all of the above, the intended target for the project is therefore for all patrons to have left the concourse within 8 minutes.

The IFEG characterises the detection and evacuation timeline by the following sequence of events:

- Fire initiation (t_o): time at which fire occurs
- Occurrence of cue (t_c): time of a cue that indicates the occurrence of a fire. The cue may be from an automatic alarm device, aspects of the fire itself or people warning others

- Recognition of cue (t_r): time at which occupants, having received a cue, recognises it as an indication of a fire
- Initiation of movement (t_d): time at which occupants begin the evacuation movement. This may occur after a delay during which occupants carry out other actions (including 'no action')
- Completion of movement (t_m): time when occupants reach an (internal or external) safe area

Figure 9-2 below describes the relationship between the detection and evacuation timeline and the RSET components. These discrete events are separated by the following series of time periods that collectively make up the components of the RSET equation:

- Cue Period (P_c)
- Response Period (P_r)
- Delay Period (P_d)
- Movement Period (P_m)

Such that
RSET = $P_c + P_r + P_d + P_m$

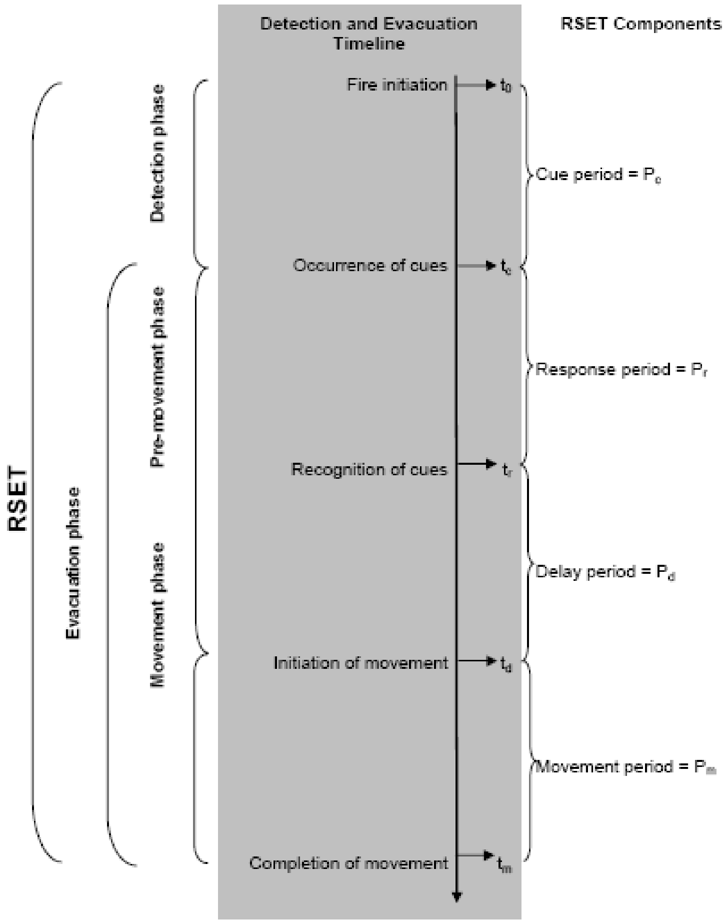


Figure 9-2: Detection and Evacuation Timeline (reproduced from IFEG 2005)

9.4.7 Overview of STEPS

STEPS (**S**imulator of **T**ransient **E**vacuation and **P**edestrian movement**S**) may be viewed as three interconnecting components: the specification of the path network, the description of the human characteristics and the movement of the people on the paths. In order to gain further insight into these three components a graphical interface has been developed which is active during the actual simulation process. This allows the user to observe how people behave and travel towards exits, move along stairs and escalators and cause crowds or bottlenecks within the system. In addition, counters and timers displayed on the screen allow for the monitoring of use and timings at individual sections or for the complete building. These may reveal many other interesting considerations such as the number of people on each set of stairs. Graphs of the flow rate showing the number of people passing through individual sections such as stairways or exits as a function of time can be produced to aid analysis of the simulation.

Analysis of individual paths taken may also be performed by recording and replaying their movements. This can further determine individual waiting times, distances travelled and changes in routings in case of bottlenecks or closed exits. For the initial development of the model various assumptions needed to be made. Firstly, the model assumes that people know they have to egress the building and hence, move towards the exits. Their movement is determined by taking into account a number of factors such as their location, the number of people around them and their travelling speed. The other assumptions will be discussed in the following sections describing each component and their subsequent interactions.

The prescription of the numerous possible routings through the building complex is a hybrid between network and decision approach models and may be defined in two ways. The first uses pre-defined paths such as stairways, on which deviations of the walking directions are not possible until another intersection of crossing paths is reached. Alternatively, planes which might contain a number of exits may be specified. In these locations people are able to evacuate and decide on a ‘goal’ exit based on specific criteria.

9.5 Available Safe Egress Time (ASET)

9.5.1 Design fire computer model

Available safe egress time (ASET) will be determined using computer modelling of fire and smoke conditions within the building resulting from the relevant design fire scenario or scenarios for the duration of the evacuation period, including a suitable safety factor. Computational Fluid Dynamics (CFD) modelling will be used to calculate ASET. CFD analysis divides a control volume into a very large number of small three-dimensional cells. Relationships describing the conservation of mass, momentum and energy, in the form of the Navier-Stokes equations are solved numerically, across the faces of each of these cells at small time steps. This provides a powerful predictive tool enabling a more accurate calculation of the changing hazardous environmental conditions.

9.5.2 Fire Dynamics Simulator

The CFD program Fire Dynamics Simulator (FDS), Version 5 (McGratten 2007), will be used to model the spread of fire and smoke as part of the ASET analysis. FDS was developed by the National Institute of Standards and Technology (NIST) in the US, and is specifically designed to analyse fire flow physics.

9.5.3 PyroSim

PyroSim (Thunderhead 2008) is an interactive, graphical user interface (or front end) for FDS. The PyroSim interface enables visual construction of the model in a manner similar to CAD programmes, and also ensures the correct format for the FDS input file. In addition, PyroSim offers high-level 2D and 3D geometry creation features, such as diagonal walls, background images for sketching, object grouping, flexible display options, as well as copying and replication of obstructions.

9.5.4 Smokeview

Smokeview (Forney 2007) is as an advanced scientific software tool designed to visualize numerical predictions generated by fire models such as FDS. Smokeview performs this visualization by displaying time dependent tracer particle flow, animated contour slices of computed gas variables and surface data. Smokeview also presents contours and vector plots of static data anywhere within a simulation scene at a fixed time. Smokeview can be used before, during and after model runs. Smokeview is used in a post-processing step to visualize FDS data after a calculation has been completed. Smokeview may also be used during a calculation to monitor a simulation's progress and before a calculation to setup FDS input files more quickly, one can also use Smokeview to edit or create blockages by specifying the size, location and/or material properties.

10. Acceptance criteria

10.1 Occupant life safety

The Acceptance Criteria have been developed cognisant of the level of Building Importance, objectives of the BCA, the relevant Performance Requirements and the relative DTS provisions.

The Acceptance Criteria have been developed in accordance with the interpretations of the Guide to the BCA, which is “recognised as the authoritative commentary on the BCA by all State and Territory administrations and will be the only BCA reference work which can be confidently used with the knowledge that the State regulatory authority has vetted and approved its content” (ABCB Australian Building Regulation Bulletin, Issue 3, Spring 1997) The Guide also provides “common, nationally consistent interpretations of all the Performance and Deemed-to-Satisfy provisions of Volume One of BCA96.” (ABCB Australian Building Regulation Bulletin, Issue 5, Winter 1998).

The life safety of occupants will be evaluated using a quantitative 'timeline' assessment, which involves determining the time to untenable conditions (ASET) in the egress paths and compares these with the time required for evacuation (RSET).

The acceptance criterion for occupant safety is:

ASET > RSET

The shortest time period is determined to be equivalent to the ASET value.

Heat convection

Direct exposure to hot gases will cause breathing difficulties, which may inhibit occupant escape. A limiting hot layer temperature of 100 ºC when the hot layer is below 2.1 m above the floor level is considered reasonable for most buildings. However, for particularly susceptible occupants such as disabled occupants where escape times maybe longer, the IFEG advises that consideration should be given to using a maximum limit of 60 ºC as the tenability criteria for convective heat.

Heat radiation

The limiting condition for radiation is assumed to be 2.5 kW/m^2. This equates to a hot layer temperature of 200 ºC for ceilings of approximately 3 – 5 m. Values above this may lead to heat stroke and skin burns, disabling the occupant and preventing escape. The tolerance time for radiation at this level is more than 5 minutes. In high ceiling areas the limiting radiation is higher and will be assessed accordingly.

Visibility

Dense smoke may obscure exit paths, slowing or preventing escape. The FSEG suggests that if a smoke optical density of less than 0.1 m^{-1} or 10 m visibility is maintained in the occupied zone, then visibility would be considered satisfactory for large enclosures. The smoke optical density can be doubled for a small room (i.e. visibility threshold of 5 m). A smoke optical density criterion of 0.1 m^{-1} or 10 m visibility is considered applicable as most areas considered are large spaces. 5 m visibility is applied to small areas, and when occupants are queuing at an exit. Smoke optical density levels will be measured 2.1 m above floor level.

Toxicity

The toxicity of combustion products varies widely according to the properties of the fuel. However, the IFEG suggests that limiting conditions for all toxic products (asphyxiants and irritants) are unlikely to be exceeded for up to 30 minutes if the smoke optical density does not exceed 0.1 m^{-1} (i.e. equivalent visibility distance of 10 m). As part of this assessment, it is assumed that toxicity will not need to be assessed providing the visibility threshold has not been exceeded. Should toxicity need to be assessed, the Fractional Effective Dose (FED) method will be used to assess CO, CO_2, and O_2 levels at a height of 1.5 m above floor level. A toxicity threshold of 0.3 FED will be used, as suggested in ISO/TS 13571.

Table 10-1: Summary of Acceptance Criteria for ASET

Convective heat	Temperature < 60 °C when smoke layer is below 2.1 m
Radiant heat exposure	Radiant flux < 2.5 kW/m^2 at 2.0 m, or smoke layer temperature < 200 ºC when smoke layer is at or above 2.1 m
Visibility	Visibility > 10 m when smoke layer is below height of 2.1 m for large spaces, visibility > 5 m when smoke layer is below height of 2.1 m for small spaces or when queuing at an exit
Toxicity	Toxicity < 0.3 FED at a height of 1.5 m when visibility threshold has been exceeded (FED assessed on CO, CO_2 and O_2 concentrations)

10.2 Factor of Safety

10.2.1 Background

Occupants are considered to have evacuated safely when:

ASET ≥ RSET+ safety margin

A safety margin is included in the ASET/RSET calculation to reflect the variability and uncertainty in both the methodology, and the input parameters used. The size of the safety margin should reflect the degree of uncertainty associated with a particular analysis. It is often difficult to accurately quantify the magnitude of uncertainty within an analysis, and therefore a significant degree of subjectivity is unavoidable in the selection of a safety margin or safety factor. The Fire Engineering Design Guidelines (Ed. Buchanan, 2001) has the following to say regarding safety margins:

"The safety margin is required to account for uncertainties in calculating the likely evacuation and tenability times, difficulties in finding the way, and other unforeseen circumstances. The safety margin selected may vary depending on occupant characteristics (age, disability, sleeping or active occupancies), presence of suppression systems, and building size or complexity. In the absence of better information, a safety margin of not less than t_{ev} is suggested for alert able-bodied people. A more detailed analysis may be carried out as justification for using a different safety margin. Selection of the safety margin depends on whether the compared times are expected values or extreme values of the parent distributions."

In the FEDG, t_{ev} is equivalent to RSET. Consideration also needs to be given as to whether a safety factor or a safety margin is more appropriate. In discussing uncertainty Notarianni (SFPE Handbook, Section 5-4, 2002) identifies the following differences between safety factors and safety margins:

"The idea of a safety factor is that the design values are multiplied by the factor of safety and the design is checked to ensure that the design is safe at the larger value (i.e., the product of the design value and the safety factor). Safety margins are a slightly different concept. A safety margin is additive and not multiplicative. A safety margin is defined as the difference between the design value and the value that would no longer be safe."

By stating that the safety margin should not be less than t_{ev}, the FEDG is effectively describing a minimum safety factor of 2. Notarianni also states that when an explicit factor of safety is applied, one may chose a value of 1.5, 2, or even higher.

10.2.2 Design safety factor/safety margin

As well as considering the underpinning principles discussed above, any decision regarding appropriate safety factors or margins must take into account both the level of safety provided by the building's fire safety systems, and the level of conservatism inherent in the design fire scenarios.

In this case the building's design and fire safety systems include a number of aspects that will significantly improve egress times and improve tenability during egress, particularly the open nature of the stands.

Therefore for this analysis the greater of a safety factor of 0.5 RSET, or a safety margin of 120 s, is considered appropriate.

10.3 Fire Brigade Intervention

The building has several fire stations in close proximity, the closest of which are located at 37 Church St, Lidcombe and 153 Concord Rd, Concord. These stations are 3.2 and 3.6 km away respectively.

Where the fire engineering assessment requires an assessment of fire brigade tenability to be made, the following limits of acceptability will apply based on the Australasian Fire Authorities Council's, Fire Brigade Intervention Model:

Routine Condition

Elevated temperatures, but not direct thermal radiation

- Maximum Time: 25 minutes
- Maximum Air Temperature: 100℃ (in low layer)
- Maximum Radiation: 1 kW/m^2

Hazardous Condition

Where fire-fighters would be expected to operate for a short period of time in high temperatures in combination with direct thermal radiation

- Maximum Time: 10 minutes
- Maximum Air Temperature: 120℃ (at or below 2.1m h eight)
- Maximum Radiation: 3 kW/m^2

Extreme Condition

These conditions would be encountered in a snatch rescue situation or a retreat from a flashover

- Maximum Time: 1 minute
- Maximum Air Temperature: 160ºC (in lower layer)
- Maximum Air Temperature: 280ºC (in upper layer)
- Maximum Radiation: 4 - 4.5 kW/m^2

Critical Conditions

Fire-fighters would not be expected to operate in these conditions, but could be encountered. Considered to be life threatening

- Time: < 1 minute
- Air Temperature: > 235ºC (in lower layer)
- Radiation: > 10kW/m^2

While fire-fighters can search under fire conditions which are untenable to building occupants, it is unlikely that the occupants will survive in this atmosphere; therefore these conditions are not satisfactory design criteria for occupant safety. Search and rescue cannot be undertaken in a compartment which has reached flashover, and it is not expected that occupants will survive in such an environment.

It should be noted that the Fire Brigade Intervention Model does not set an acceptance criteria for visibility. This reflects the fact that Fire Brigade personnel are trained to work in smoke-logged environments and are provided with protective equipment, including heat-shielding clothing and breathing apparatus, that facilitates such activities.

10.4 Property, Asset and Business Protection

There is no specific acceptance criteria required by the Client with respect to protection of the subject property, assets within the property or business interests related to the property.

The property protection measures to be included in the building shall be instructed to the Client. The fire engineering study will not provide an assessment of the level of property protection against any particular acceptance criteria.

The protection of property from fire is an issue that requires clarification for each project being assessed through a performance based approach. The Productivity Commission Report of 2004 entitled "Reform of Building Regulation" has indicated the following regarding BCA fire safety objectives:

"The ABCB Chairman submitted that the BCA's goal in the area of fire safety is:

...to protect the lives of building occupants, facilitate fire brigade intervention in the even of emergency, and protect adjacent property from the spread of fire and physical damage caused by structural failure.
It would appear to be generally accepted that the property protection of a building that is on fire is not a primary objective of the Code (although a level of property protection would often be an indirect consequence of fire safety measures directed at protecting building occupants). Provided the BCA's spread of fire criteria have been satisfied, a building may burn down and technically still have complied with the performance requirements of the Code."

Each State and Territory has its own Fire Brigade or Fire Service Act that has its own set of fire safety objectives, which may differ from those of the BCA, in respect to the protection of property. There may also be differing requirements from insurers with regard to protection of property and business interruption. Report Finding 6.4 states the following:

"The degree of property protection from fire in the objectives of the BCA is different to that generally required by fire authorities' legislation (and some insurance companies) in relation to building performance, particularly for commercial buildings."

In an attempt to resolve the issue of conflicting objectives, the Productivity Commission Report provided the following guidance:

"As a general principle, property owners are best placed to determine the optimal level of fire protection, based on their expectations with respect to the risk of a fire incident and the estimated financial and other losses should a fire event occur. With an efficient insurance market, premiums would accurately reflect differences in risk, and provide further signals/incentives to the building owner to achieve the appropriate trade-off between risk exposure and cost of property protection measures."
The above information is provided in this report so that the building owner can make themselves aware of the BCA objectives regarding protection of property from fire.

10.5 Environmental and Community Protection

There are no specific acceptance criteria required by the Client with respect to the environmental or community protection. Our Client has not advised us that this building is required to fulfil a special purpose in the community.

11. Standards of construction, commissioning, management, use and maintenance

All fire safety systems to be provided in this building shall be installed in accordance to the relevant standards and the manufacturer's technical information unless otherwise noted herein. Industry practice should be followed at all times.

Commissioning should be carried out in accordance with the relevant standards. Commissioning and integrated function testing of all fire safety systems including interfaces should be carried out to ensure proper function.

The 'Management-in-Use (MIU) Fire Safety Plan' which incorporates the ongoing fire safety of the building shall be checked to determine if it includes the following items, and shall be updated to include these items if not already present:

- General house-keeping must be undertaken to maintain the egress paths and exits clear in order to allow unimpeded travel.
- Egress path via the right-of-way must be maintained at all times the building is in use.
- Emergency control organisation and procedures in accordance with AS 3745:2002 shall be developed and implemented.
- Development of emergency procedures shall be accompanied by regular staff training and induction, to direct occupants to the nearest exit in the event of a fire alarm as well as keeping the paths of travel to exits clear of items that constitute a fire load or impede occupant egress. Training should include first action fire fighting training in the use of fire extinguishers and fire hose reels.
- No smoking policy is to be implemented in all areas.
- Commissioning and integrated function testing of all fire safety systems including interfaces to ensure proper function

There is the potential for penetrations in fire walls to compromise the fire separation's integrity, particularly over the life of the building. It is recommended that penetration zones are nominated within fire walls for ease of inspection and maintenance.

Maintenance works of the fire safety measures are the responsibly of the Building Owner or appointed Manager. An annual maintenance statement is to be displayed within the main entrance. Notice of the Alternative Solutions shall also be prominently displayed at the Fire Indicator Panel (FIP).

All essential services are to be maintained and tested in accordance with the requirements of AS1851-2005 and their system-specific Australian Standards. A schedule of essential fire safety measures and their system-specific Standard will be provided when the relevant facets of the design are determined.

12. References

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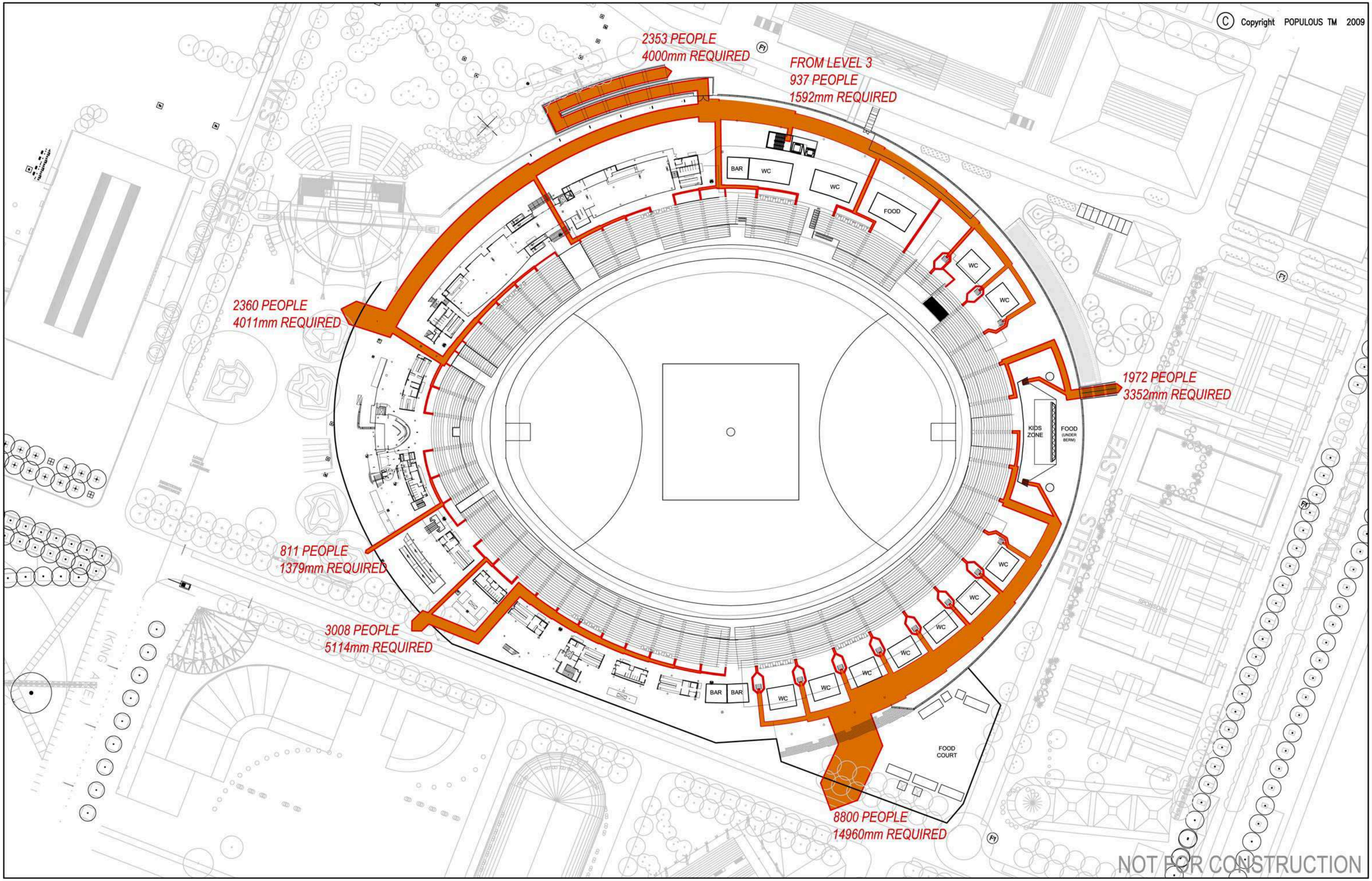
Appendix A
Preliminary egress drawings

Appendix A



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SYDNEY SHOW GROUNDS REDEVELOPMENT

Level 02 - Stage 1a & 2

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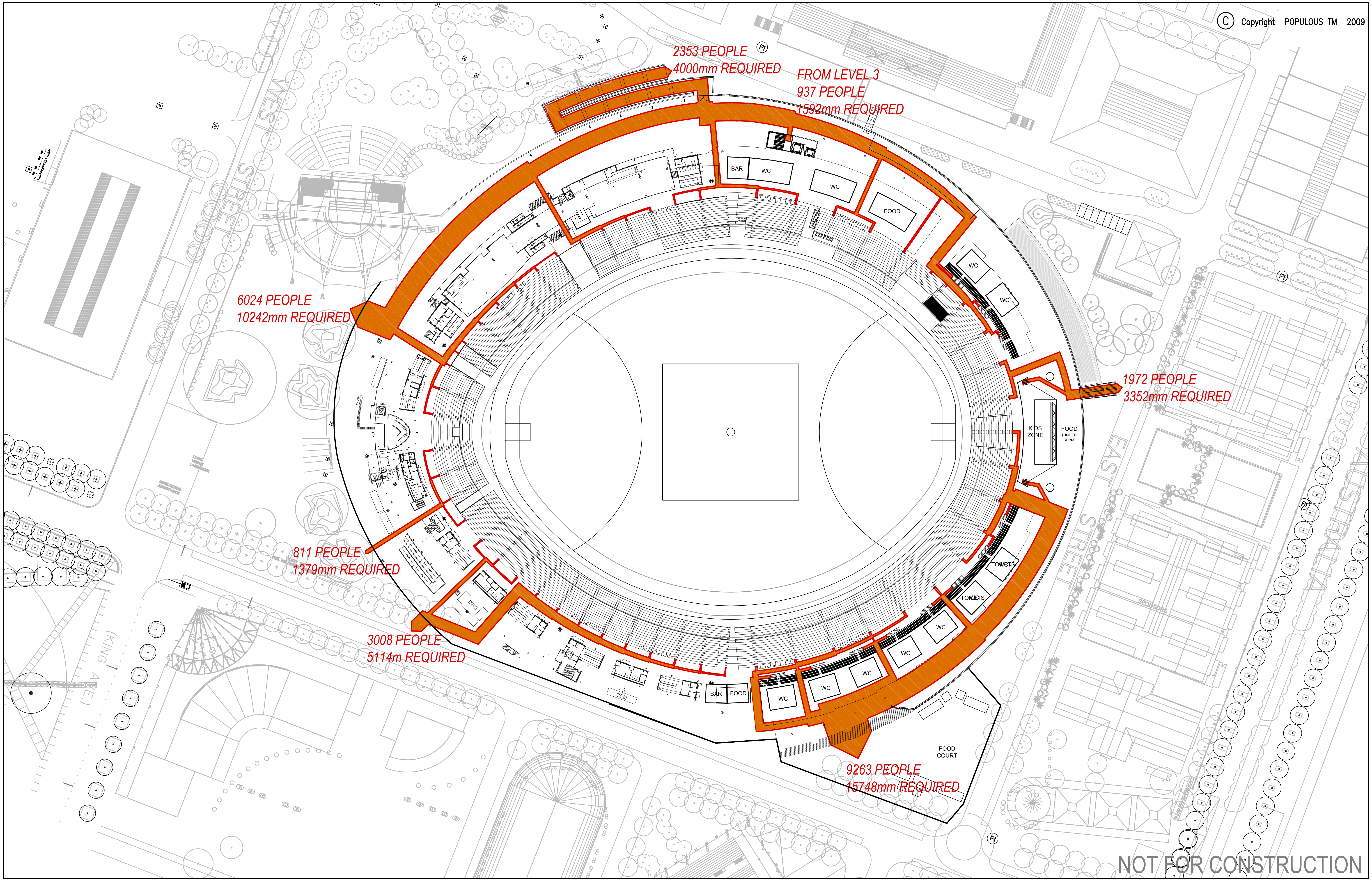

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SYDNEY SHOW GROUNDS REDEVELOPMENT

Level 02 - Stage 1

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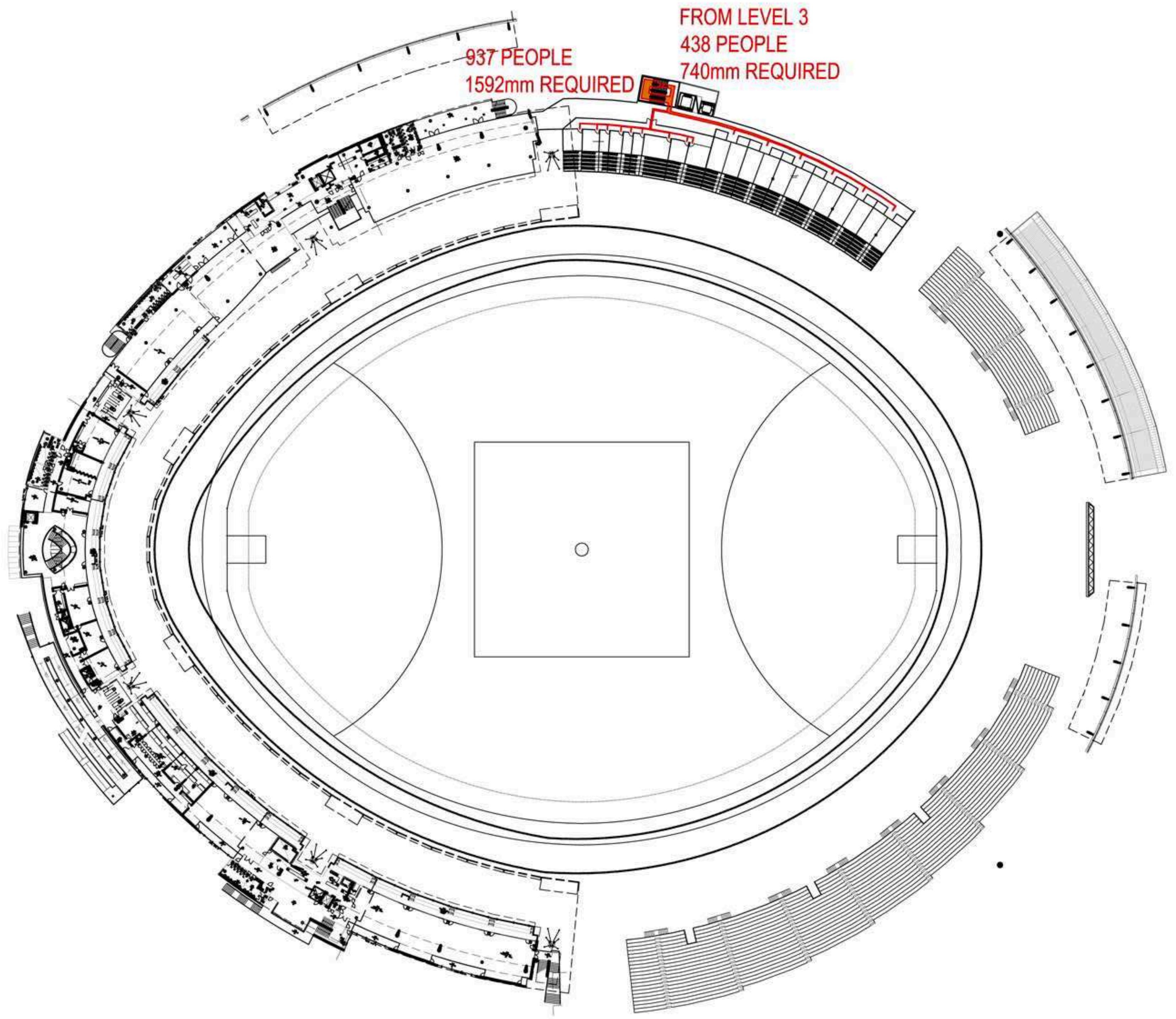

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SYDNEY SHOW GROUNDS REDEVELOPMENT

Level 03 - Stages 1, 1a & 2

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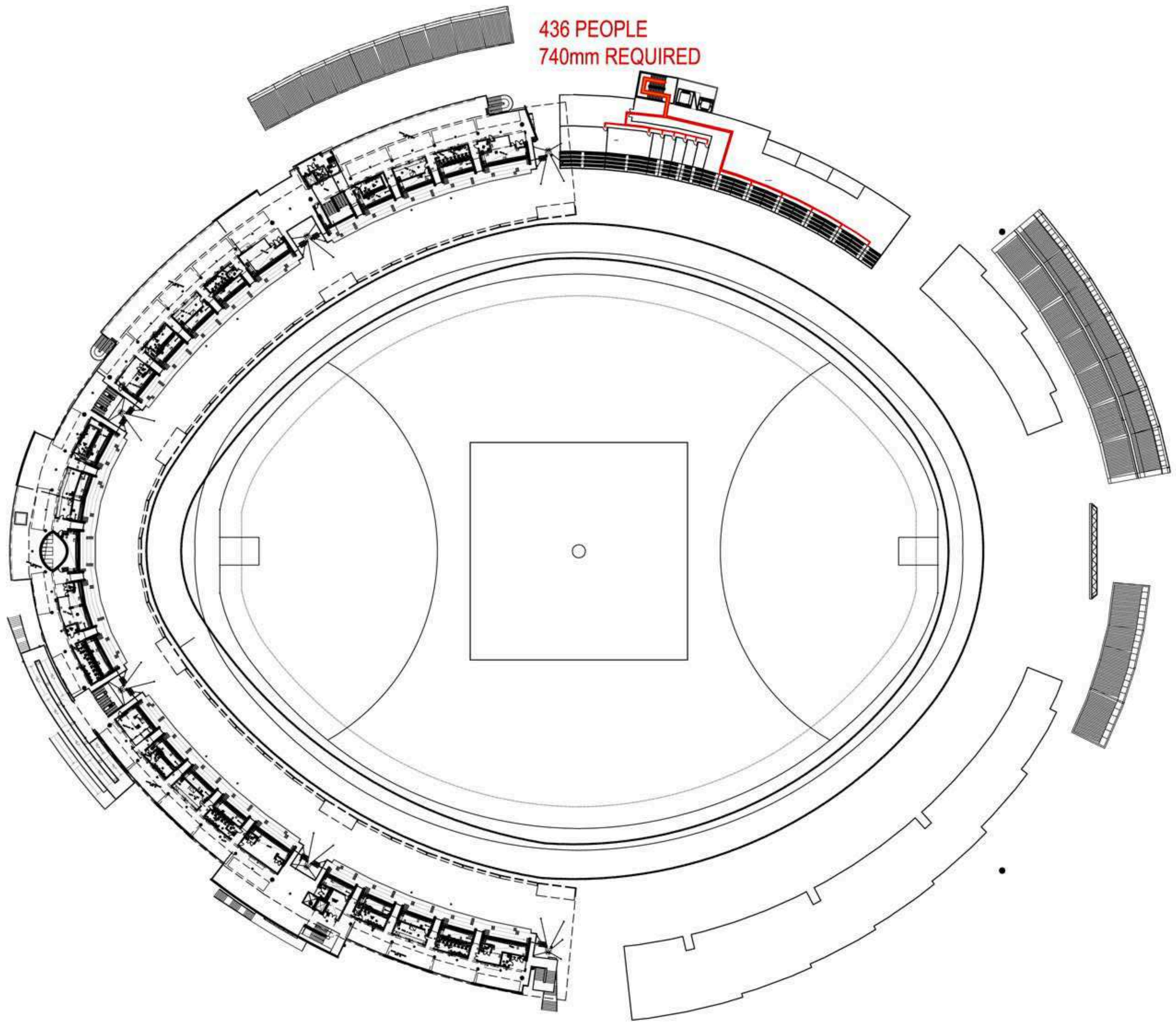

NOT FOR CONSTRUCTION

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SYDNEY SHOW GROUNDS REDEVELOPMENT

Level 04 - Stages 1,1a & 2

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