QUEENSLAND DEVELOPMENT CODE PART 3.7 – FARM BUILDINGS

Independent Review – Fire Engineering Report – Final

Issue – Final

24/04/2015

Quality Management

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Executive Summary

WSP Buildings Pty Ltd has been appointed by Department of Housing and Public Works to undertake a technical desktop review of the Queensland Development Code (QDC) Part 3.7 – Farm Buildings

Our scope is limited to providing a desktop review to either accept or refute the acceptable solutions specified in the draft QDC Part 3.7 document, from a technical view point only. A summary of the outcomes for deemed acceptable solutions are tabulated below for ease of reference:-

Glossary of Terminology Used

For meaning of certain standard terminology used in Fire Engineering, reference can be made to Appendix A which contains a list of terminology that may be used in this document. Should any specific terminology not be listed enquiry can be made with the author of this document, or other representative of WSP Buildings Pty Ltd.

In addition to the key outcomes tabulated in the schedules below, few key general observations on the draft QDC Part 3.7 are made for consideration:-

- **Retrospective legislation:**

  The extent to which the proposed draft QDC Part 3.7 is to be retrospectively implemented into farm buildings will require consideration by QDC.

- **Modelling:**

  Zone model computational fire simulations are utilized to determine the conjectural fire scenarios under investigation. In this instance it is a limited analysis which relates to the Terms of Reference associated with this report.

- **Fire Brigade Intervention:**

  The location of a remote farm building has a major impact on the fire crew to be able to undertake firefighting measures. This is mainly due to distances required to travel to a remote site, which varies. It is therefore considered reasonable to state that fire crew upon arrival would face a fire that might be well developed (or in decay stage assuming fire development is sustained) and would undertake only external firefighting measures to extinguish the fire and also to protect any structures in the vicinity of the building on fire. For this reason fire brigade search and rescue inside a fully involved building is not considered commensurate with modelling undertaken. However QDC Part 3.7 Performance Requirement P5 and Acceptable Solution A5 “Firefighting Equipment – Fire Hydrants and Water Supply” is considered as reflected in this report.

Table 1: Review outcomes for "Acceptable Solutions" A1 to A9 (Refer Individual Assessments)

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A1 – Compartment and Separation	Refuted	The concession to remove the requirements of BCA clause C 2.3 (a)(i)(B) is refuted because fire spread between buildings would be likely to occur which will cause an increased risk to occupant life safety, fire crew safety and property. Due to the lack of separation distances, the fire crew intervention of a fire event will be significantly hindered. This in turn will cause an increased risk to the fire crew attending to a farm building fire.	A minimum separation distance of 6m (*in lieu of the 18m required under BCA clause C 2.3 (a)(i)(B)*) would be necessary to minimise the risk of fire spread and also facilitate fire crew firefighting activities. Same could be considered plausible for grouped buildings when related to distance from side or rear boundaries; unless the Certifying Authority's assessment related directly to vehicular access for firefighting operations, show that perimeter access around a building or grouped buildings would be required when spaced apart at a minimum separation distance of 6m.

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A2 – Smoke Hazard Management	Acceptable Based on BCA-DTS travel distances in accordance with D1.4 and D1.5	A series of plausible fire growth scenarios were studied against different ceiling heights for 1000m^2 and 2000m^2 buildings. On the basis of the quantitative studies applied, the results have shown that only large volume buildings (assessments were limited to 1000m^2 and 2000m^2 buildings) with sufficient ceiling height would have a sufficient smoke reservoir to facilitate safe evacuation.	It is our view that the current deemed to-satisfy BCA 20/40m travel distances and 60m distance between exits should be retained before subsection (2) of A2 can be omitted, or whereas reference to this may need to be adjusted for limiting influences where building structures between 500m^2 and 1000m^2 are applied.
A3 – Access and Egress	Refuted	The concessions to allow an increased travel distance above those specified in the BCA clauses D 1.4 and D 1.5 is refuted. In certain specific trial building geometry designs it was found that the proposed increase in travel distances as outlined in draft QDC Part 3.7 would directly impact on life safety of the occupants due to onset of untenable conditions.	It is our view that the travel distance would need to be compliant with BCA clause D 1.4 Exit travel distances and BCA Clause D 1.5 Distance between alternative exits. This will cater for variances in building design and uncertainties associated in various functional usages, including closure of open sided buildings for reason of weather or influencing factors. Door swing direction for exits and exit door hardware in paths of travel to exits should be retained as in the BCA – Volume 1 provisions.

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A4 – Fire Fighting Equipment – Fire hose reel systems and fire extinguishers	Acceptable	The provision of hazard specific first fire attack equipment such as portable fire extinguishers would aid in occupant intervention if safe to do so. Further, given the limited supply of extinguishing medium in the portable fire extinguisher the occupants are likely to evacuate the building once all extinguishing medium is released. This would not be the case when a fire hose reel is used which would have unlimited water supply for the occupants to undertake intervention, assuming safe conditions prevail to do so.	It is our view that the draft QDC part 3.7 – acceptable solution A4 (b) (i) for portable fire extinguishers at not less than 5BE (carbon dioxide) must be provided in each room containing flammable materials or electrical equipment, be replaced to ABE fire extinguishers instead. The main reason being, carbon dioxide fire extinguishers are prone to issues such as (1) the fire extinguisher being empty due to leak and (2) occupants not trained in the use of these type of fire extinguishers. Location and quantities as intended by the BCA deemed to satisfy provisions should be retained. Specific content of buildings will require consideration for selection and placement of specific type extinguishers. For example significant amount of Class A combustibles associated with a building warrants consideration for water based extinguishers or sufficient number to make up an appropriate mix of extinguishers where mixed commodities are involved.

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A5 – Fire Fighting Equipment – Fire hydrant system and water supply for firefighting.	Acceptable	The provision of a fire hydrant system along with a 2 hour water supply and at least 20L/s (floor area > 500m^2) would aid the fire brigade in their intervention activities. Consideration is with reference to outlets in accordance with AS2419.1-2005 Table 2.1 and in relation to Item 4 subsection (2) of draft QDC Part 3.7. Assuming compartmentation and separating distances are applied with reference to the provisions contained in draft QDC Part 3.7 and this report.	It is our view that if the farm building is located at a distance of more than 30minutes from a local responding fire station, it is unlikely for a fire hydrant system or onsite water storage for firefighting to be of merit since a building fire is likely at or close to its decay stage upon fire brigade arrival on a remote site. Assuming minimum separating distances between buildings and to boundaries are maintained, the requirement for a 144,000lts water supply for firefighting appears to be onerous. Reducing the water supply demand to 72,000lts (1 hour) may be more in line with realistic estimation on anticipated water supply requirements for the fire crew. A fire water reservoir or tank capable of 50% - 50% reserve, or reserved water in a single tank dedicated for firefighting, would improve available water supplies in conjunction with the proposed QDC concession. It is our view that the requirement for the onsite water storage tank to be located within 150m of the most distant point of the building (measured along the perimeter of the building) appears to be onerous in terms of application for the farm building operators. Consideration for further consultation with fire brigade to provide further concessions to remove this requirement is recommended. The usage of the onsite storage (such as a distant water reservoir) along with water reticulation being suitable to cater for fire hydrant usage may be options for consideration.

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A6 – Emergency lighting	Acceptable	In buildings where the welfare of the animals being kept is affected by emergency lighting, the occupants of the building will be trained to be familiar with the building and to operate in the low light areas. The occupants are likely to be able to identify exits and traverse obstacles in order to evacuate the building in case of a fire in low light conditions The concession provided in the draft QDC part 3.7 is in accordance with the guide to the BCA explanation of the intent of the BCA clause EP 4.1 which is the performance clause for emergency lighting. The draft QDC part 3.7 and the BCA are in agreement on this topic for farm buildings.	It is understood that due to potential adverse effects of artificial lighting on some animals site specific operators use headlamps and / or torches to facilitate operations whilst animals are in place outside of daylight hours. Placement of permanent chargeable battery lamp packs at the main entrance may assist towards general availability for manageable access to the buildings.
A7 – Exit signs	Acceptable	The concession provided in the draft QDC Part 3.7 is in accordance with the explanation of the intent of the BCA clause EP 4.1 which is the performance clause for emergency lighting. The draft QDC Part 3.7 and the BCA are in agreement on this topic for farm buildings.	It is our view that non-illuminated reflective signs could be used in farm buildings where the occupants will be required to work with no natural lighting. This will provide a means of the occupants if they are disoriented to find an exit. Font size relative to applied visual distances should follow AS/NZS2293.1. Where reflective signs are applied they should be checked annually for maintained illuminance / visibility and should be replaced as necessary.
A8 – Artificial Lighting	Acceptable	The concession is bespoke to farm buildings that operate in low light areas. Hence acceptable.	-

QDC Draft Part 3.7	WSP recommendation to accept/ refute	Justification to either accept or refute	WSP View on QDC Part 3.7 solution
A9 – Requirements for vehicle storage farm buildings	Refuted	Providing a concession for certain vehicle storage farm buildings to be classed as a Class 10a in lieu of Class 7 would cause an increased risk of fire spread to adjacent properties, increase the risk to the safety of occupants and safety of the intervening fire crew.	A minimum separation distance of 3m from the property boundary would reduce the potential risk of fire spread, and to that of occupants and fire crew. This would be in accordance with the separation distance requirements for Class 7a buildings as outlined in the BCA. A minimum separation distance of 6m between buildings on the same allotment would reduce the potential risk of fire spread, and to that of occupants and fire crew. Refer also to comments raised under A1 above. If the physical distance separations cannot be provided, the fire wall will be required to have a minimum fire resistance level of 60/60/60 in line with that of Class 10 buildings as outlined in the BCA.

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1 Introduction

1.1 Contractual Context

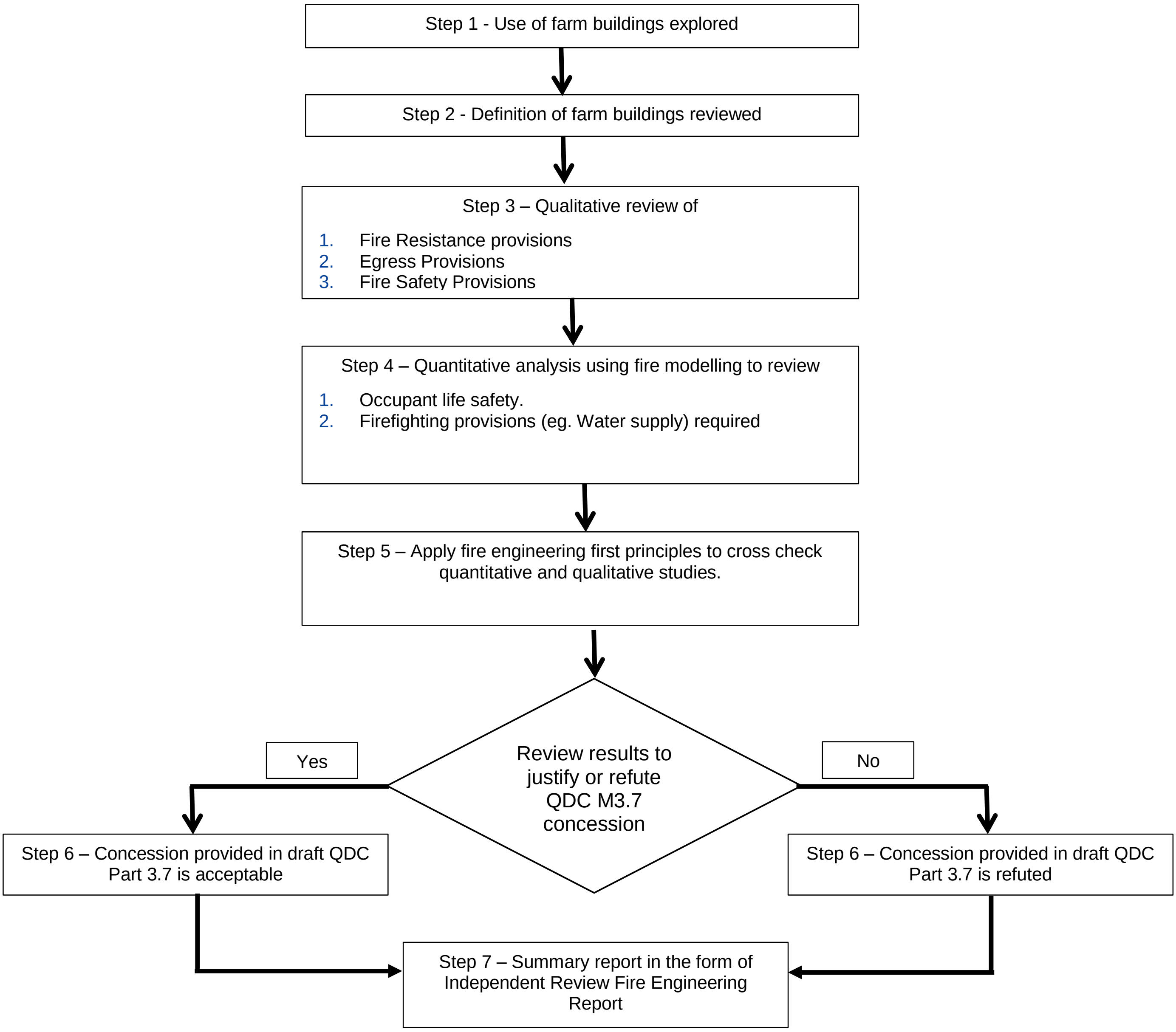
WSP Buildings Pty Ltd has been appointed by Department of Housing and Public Works to undertake a technical desktop review of the Queensland Development Code Part 3.7 – Farm Buildings draft document.

Our scope is limited to providing a technical desktop review to either accept or refute the acceptable solutions specified in the document from a technical view point only. The desktop review included the visiting one representative industry farm as authorised by the Department of Housing and Public Works.

Our scope also encompasses providing our unbiased views on the proposed acceptable solutions as contained in the draft document. Views expressed are generic only and are retained in this document with an objective, where warranted, to facilitate discussion between key stakeholders and for Building Codes Queensland to accomplish an agreed way forward.

It's vital to note that WSP's engagement is not to collate and provide comment on all available information/discussions in relation to QDC Part 3.7.

The below flow chart explains our agreed approach with the Department of Housing and Public Works. Detailed explanation of each step is provided below:-



1.2 Project Schedule

The Department of Housing and Public Works and WSP Buildings have agreed upon the below project schedule in regard to the delivery of the above stated scope of works.

The below table does not reflect the entire project implementation time frames. It only relates to the works currently commissioned to be undertaken by WSP.

Table 2: Project Schedule

Works	Delivery Dates	Comments
1 x Farm site visit	Monday 19th Jan 2015	Completed
1 x QFES meeting	Tuesday 20th Jan 2015	Completed
Draft (interim) report	Friday 23rd Jan 2015	Completed
1 x QDC/BAS meeting	Friday 23rd Jan 2015	Re-Scheduled for 16th February 2014
Review period	Tuesday 27th Jan 2015	Further to meeting discussions on Tuesday 20th Jan 2015 it is our understanding that this period will be further extended by the Department of Housing and Public Works as required.
Final report	Wednesday 18th Feb 2015 The time period for issuing the final report is dependent on the extent of feedback comments received by WSP.	Final report incorporating feedback comments where relevant.

1.3 Stakeholders and documentation

The relevant stakeholders of this scheme are listed in Table 3

Table 3: Relevant Stakeholders

Organisation	Role	Name
Department of Housing and Public Works (Building and Asset Services)	Client Representative	Rob Wallace Alan Chau
Department of Housing and Public Works (Building and Asset Services)	Certification Advisor	Cath Patterson
Queensland Fire and Emergency Service	Advise Agency	David Brazel Neil Dansie
WSP	Fire Safety Consultants	Chris Sheeran (RPEQ11900) Franz Venter (supervised by James Boyes) James Boyes (RPEQ10183)

1.4 Reference documentation

The below documents are the basis for our assessment since they have been directly provided by the Department of Housing and Public Works for the technical review.

Table 4: Referenced Documentation

Document Name	Organisation	Date	Revision
Queensland Development Code, Part 3.7 – Farm Buildings	Department of Housing and Public Works	01.09.2014	-
Discussion paper – Farm Buildings	Australian Building Codes Board	01.11.2014	-

2 Farm Building Characteristics

2.1 General

To undertake a review of the building characteristics of a farm building, the below topics are explored in the context of codes/legislations from around the world that are readily available online.

This section is vital since it would provide context into the technical review of the acceptance solutions specified in the draft QDC Part 3.7. The topics reviewed are

1. Use of farm buildings.
2. Definition of farm buildings
3. Location.
4. Size and shape.
5. Structure.
6. Hazards.
7. Management-In Use & Environmental Conditions.
8. Occupant loading.
9. Occupant Characteristics.

2.2 Use of Farm Buildings

The purpose of this section is to provide context into the various uses considered by different codes/legislation into which type of *building use* would fall under the category of a “farm” building. Examples provided on the types of farm buildings is also reviewed.

Table 5: Use of farm buildings from various codes/legislation

Name of code/legislation	Description of use of farm building as specified in the relevant code/legislation	Types of farm buildings
International Building Code (IBC)	Metal Shed, open and closed sides, including traditional Barns and Pole building Structures.	Livestock shelters or buildings, Poultry buildings or shelters, Barns, Storage of equipment and machinery used exclusively in agriculture, Horticultural structures, including detached production greenhouses and crop protection shelters, Sheds, Grain silos, Stables.
NFPA 5000	Metal Shed, open and closed sides, including traditional Barns and Pole building Structures.	Livestock shelters or buildings, Poultry buildings or shelters, Barns, Storage of equipment and machinery used exclusively in agriculture, Horticultural structures, including detached production greenhouses and crop protection shelters, Sheds, Grain silos, Stables.

Name of code/legislation	Description of use of farm building as specified in the relevant code/legislation	Types of farm buildings
NFPA 150	Category A animals shall include any of the following types of animals: (1) Animals that pose a potential risk to the health or safety of rescuers or the general public (2) Animals that cannot be removed without potential risk to the health and welfare of the animal or other animals (3) Animals that are impossible or impractical to move (4)Animals that are not mobile or not in a mobile enclosure Category B animals shall include all animals not in Category A, as specified in Class 1 Facility. A Class 1 facility shall be an area of a building housing animals with no general public access. Class 2 Facility. A Class 2 facility shall be an area of a building housing animals with restricted general public access. Class 3 Facility. A Class 3 facility shall be an area of a building housing animals with regular general public access.	Barns and stables, Kennels, Racetrack stable/kennel areas, including those stable/kennel areas, barns, and associated buildings at state, county, and local fairgrounds Animal shelters, Animal hospitals and veterinary facilities, zoos and special amusement parks, Laboratories, Agricultural facilities, Mercantile or business occupancies with animal, Racetrack Facilities.
Victoria, Australia	Farming, for the purposes of the definition of farm building, means agriculture, cropping, grazing, animal husbandry, intensive animal keeping, horticultural growing or dairy farming.	-
South Australia, Australia	Farming: For the purpose of this Minister's Specification, farming means the use of a building for any purpose of agriculture, cropping, grazing, animal husbandry, intensive animal keeping, horticultural growing facilities or dairy.	-
Canada	Farm buildings include, but are not limited to, facilities for the storage and packing of produce, housing for livestock and poultry, milking centres, manure storage, grain bins, silos, feed-preparation centres, farm workshops, greenhouses, farm retail centres, and facilities for horse riding, exercise, and training.	-

The draft QDC Part 3.7 identifies and provides examples for agricultural activities and farm buildings. In light of the above code/legislative review, it's our view that:-

1. The definition of agricultural activity as outlined in the draft QDC Part 3.7 is comprehensive.
2. The examples of farm buildings as outlined is adequate however it would be recommended to include the following in the list of examples:-

- *A building use for the sheering of sheep (although deemed under QDC Part3.7 as Farm Building)*
- *A hobby farm (deemed a Class 7 or 8 building on land used primarily for agricultural activities where one or more of the defined activities are being carried out)*

2.3 Definition of farm buildings

By understanding the manner in which the different codes/legislations "define" a "farm" building, a holistic *description of a farm building* could be ascertained.

Table 6: Definition of farm buildings from various codes/legislation

Name of code/legislation	Definition of farm buildings as specified in the relevant code/legislation
International Building Code (IBC)	A structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. This structure shall not be a place of human habitation or a place of employment where agricultural products are processed, treated or packaged, nor shall it be a place used by the public.
NFPA 5000	A building located on agricultural property used for sheltering farm implements, hay, grain, livestock, or other farm produce or equipment in which there is no human habitation and that is not used by the public.
NFPA 150	Area of a building or structure, including interior and adjacent exterior spaces, where animals are fed, rested, worked, exercised, treated, exhibited, or used for production.
New Zealand	Building or use which may be included within each classified use but are not intended for human habitation, and are accessory to the principal use of associated buildings. Examples: a carport, farm building, garage, greenhouse, machinery room, private swimming pool, public toilet, or shed
Victoria, Australia	Farm building means a building— (a) that is used for the purpose of farming; and (b) that has been classified as a Class 7b building or a Class 8 building; and (c) in which the total number of persons accommodated at any time does not exceed one person for each 200m^2 of floor area or part of such area up to a maximum of 6 persons.
South Australia, Australia	Farm building: For the purpose of this Minister's Specification, a farm building is a building that is used for the purpose of farming.
Canada	Farm building means a building which does not contain a residential occupancy and which is (a) associated with and located on land devoted to the practice of farming, and (b) used essentially for the housing of equipment or livestock, or the production, storage, or processing of agricultural and horticultural produce or feeds.

The draft QDC Part 3.7 provides a definition of farm buildings.

This definition clearly reflects that only Class 7 and Class 8 buildings are applicable under this draft code and which are distinctly different to a Class 10a Shed – the key reference point being a building used for agricultural activity is not a Class 10a.

2.4 Location

Based on the proposed activities of a farm building it would be reasonable to state that in most circumstances these type of buildings would be located in rural areas or in the outer fringes of urban area.

The location of a farm building has a major impact on the response times for emergency services, council services.

2.5 Size and Shape

The size and shape of a particular farm building is dictated by the proposed use and Client specific requirements.

2.6 Structure

The draft QDC Part 3.7 document is pertinent to buildings that are of Type C construction as defined the Building Code of Australia. Hence the farm building being class 7, 8 could potentially have a rise in storeys of 2 and meet the Type C construction requirements. The BCA under Specification C 1.1 Table 5 outlines the construction requirements for Type C construction.

2.7 Hazards

A hazard identification and analysis review has been presented below as a separate section. It is noted that various type farm activities may likely involve the use of timber shavings, saw dust or straw in their daily operations associated with livestock, including a compounded spread over the floor. This could present an increase in hazard.

2.8 Management-In-Use & Environmental Conditions

Given the function and use of these farm buildings, it's reasonable to state that the farm building operator would be cognizant of the building operating procedures to operate the building *(example – regulation of air velocity, temperature, feed and water requirements of a Chicken farm).*

Further its justifiable to state that the personal working in these farm building will be knowledgeable to work in this building or be under supervision *(example – a sheep shearing facility would have apprentice shearers under the guidance of experienced personal).*

Farm buildings located in bush fire prone areas will be subject to the relevant bush fire legislation and hence not discussed any further in this document.

2.9 Occupancy Loading

A detailed understanding of occupancy loading is vital since it is related to the fire safety provisions requirements for a building. The occupant loading parameters from various codes/legislation is tabulated below to provide context on this issue.

Table 7: Occupant loading parameters from various codes/legislation

Name of code/legislation	Occupant loading
International Building Code (IBC)	30m² per person
Canada	40m² per person
Victoria	200m² per person
New South Wales	200m² per person

The draft QDC Part 3.7 for low occupancy buildings specifies a maximum number of people carrying out an agricultural activity in the building is the HIGHER of 1 person per 200m² of the total floor area of the building or in total, maximum 6 persons. In light of the above code/legislative review, it's our view that:-

1. *Given the low occupant numbers in typical farm buildings is related to functional use as currently applied by the industry, the concession on occupant loading for low occupancy buildings is reasonable.*

2. *The proposed concessions are in line with other state legislations in Australia.*

3 Dominant Occupant Characteristics

The below descriptions on dominant occupant characteristics is intended to provide an indicative appreciation of the occupant profile in farm buildings. Broad generalisations have been made for simplification purposes.

Table 8: Occupant Characteristics

Characteristic	Comments
Distribution	The occupants will be distributed within a given farm building based on their operating procedures. (*Example:- if an employee in a chicken farm is required to pick up the carcass of chickens in a building, their distribution will be scattered at various locations of the farm building picking up the carcasses*).
State	Occupants are likely to be awake in the building since the farm building is a place of work. Visitors can also be deemed alert since they are visiting the farm building for short periods of time. Intoxicated or asleep occupants in the building are unlikely based on building use since it's a controlled place of work.
Physical attributes	Predominant number of occupants is likely to be mobile mainly due to the nature of work undertaken in the farm buildings. Predominant number of occupants is assumed to have adequate hearing and visual ability. However there may be some occupants with a degree of hearing or visual impairment which may also form part of the occupant group. The access for people with disability as invoked by the draft QDC Part 3.7 is supported. Certain farm buildings such as Chicken farm buildings would require a baffle in a doorway to facilitate their daily operation. The current proposal of 700mm would be accessible for an able bodied person but unlikely to be suitable for an occupant with disability. The nature of work undertaken in these farms would be more suitable for able bodied occupants and hence the 700mm high door baffle is unlikely to be a hindrance for these able bodied occupants.
Level of assistance required	Occupants who may be injured or have a disability at the time of fire will require assistance. The occupants who are likely to be mobile are likely to evacuate without assistance.
Level of available assistance	It is unlikely that the farm building occupants would be trained in the provision of assistance to other occupants in case of a fire or emergency event, although it is reasonable to assume that assistance rendered by occupants to one another to escape could occur. There may also be circumstances when a single person may be on duty at times.
Emergency training	It is unlikely that the farm building occupants would be provided with emergency training.
Type of occupant groups	The type of occupant groups in farm buildings will be predominantly an employer-employee relationship. This will include farm staff, Maintenance Staff. Visitors could also form part of this occupant group type.
Activity at fire outbreak	Occupants are likely to be awake in the building at the time of fire since the farm building is a place of work. Visitors can also be deemed alert since they are visiting the farm building for short periods of time.
Familiarity with surroundings	Where inducted, occupants are likely to be familiar with their surroundings. However if the occupants are to operate in a "*dark environment with no lighting*" such as in a Chicken shed where the chickens are harvested in the dark, the occupants of the building although inducted may not be fully familiar with the building exits due to the lack of light.
Familiarity with risks in relation to fire	Occupants associated with permanent and / or regular line of duty at specific sites are likely inducted and trained plus be familiar to typical tasks and risks associated with particular functional use of the building. Same is assumed where casual workers are employed under the supervision of permanent or regular workers familiar with their working surroundings.

4 Hazard Identification and Analysis

A literature review of the potential hazard and mitigation measures has been undertaken. The outcomes of the literature review are provided below.

As farms have grown larger, associated farm buildings have increased in size and value. As a result, when the large structures catch fire they prove more difficult to extinguish and the financial losses is significantly greater.

Data from the insurance services report the following: Period 2004 – 2007(Number of fire and Losses) are provided below for reference:-

Table 9: Number of fire and Losses Data from insurance service reports: Period 2004 – 2007

Year	Estimated Fire Loss, (Canada only) in USD $	Number of Major fires Year
2007	57 Million	241
2006	34 Million	205
2005	25 Million	223
2004	30 Million	196

The recent fires that have occurred in farm buildings are:-

- In early October 2014, over 4,200 piglets died in a fire at Deerfield Farms hog farm in Eagle Springs, N.C.
- In January 2014, 300,000 chickens at the S&R Egg Farm in La Grange, Wis., perished in a barn fire.
- In January 2014, 3,700 pigs were killed in a barn fire at New Horizons Farms near Hardwick, Minn.
- In February 2014 – 1,000 pigs died in a barn fire near Lafayette, Minn.
- Blaze destroys 100-year-old N.Y. dairy farm, Dairy Herd,

These costs include those associated with building structures, but not equipment, agricultural product and livestock.

There has been NO recorded incident of a human life lost due to a farm building fire.

In each year, the leading causes for preventable, determined fires were:

- Mechanical / electrical failure
- Misuse of ignition source/equipment
- Design/construction/maintenance deficiency.

The data suggests that the primary sources of ignition fall within the following classes:

- Electrical distribution equipment (circuit wiring, distribution equipment, extension cords etc.)
- Heating equipment (central heating, flue pipe, space heater etc.)
- Open flame (cutting/welding, blow torch, smoker's articles etc.)

Electrical fires are the major cause in farm building fires. The Canadian insurance industry has pointed out that, electrical systems in farm buildings, especially in older structures, is often the cause of a farm fire.

The corrosive environment found inside livestock barns, has been determined to be the leading cause of degradation or failure of electrical equipment. The degradation is typically corrosion of the exposed metal components, i.e. wires, connections, etc. The corrosion increases the resistance at these points reducing the flow of electricity through the circuit. More importantly, the increased resistance results in more of the electrical energy being converted to heat. As the corrosion levels continue to increase the heat generated can rise to ignition temperatures of materials surrounding the equipment.

5 A1 Compartmentation and Separation

5.1 Purpose

The intent of the BCA for fire compartmentation and separation is to limit the extent to which a fire can spread either within the building itself or to the neighbouring buildings. This in turn has an impact on the safety of the occupants and fire crew.

One of the key concepts of fire safety in all buildings, including farm buildings, is to limit the spread of fire with a physical barrier, known as a fire separating element. This can be a wall, ceiling or floor of a building. Whereby creating a fire compartment.

Fire separation can be achieved by virtue of the physical distance between adjoining buildings thereby reducing the risk of fire spread between buildings.

Many codes specify maximum compartment sizes, to contain a specific fire risk within an area and minimise the risk of fire spread. For the concept to work, compartment boundaries must have an adequate level of fire resistance. All openings and penetrations through these boundaries require protection with rated closures or fire stops. The level of fire-resistance required depends on the particular building application.

5.2 Legislation Comparison

The purpose of this section is to provide context into the various compartment separation requirements considered by different codes/legislation for "farm" building.

Table 10: Legislation Comparison for Compartmentation and Separation

Name of code/legislation	Compartmentation and Separation
International Building Code (IBC)	There is no limit placed on the building compartment size and volume if the building is surrounded and adjoined by public ways or yards not less than 60 feet (18.2m) in width.
NFPA 150	Animal housing facilities to be separated with a 2-hour fire resistance-rated enclosure from hazardous areas, including, but not limited to, feed rooms, tack rooms, vehicle or equipment storage rooms, blacksmith shops, kitchens, mechanical equipment rooms, and similar areas. In buildings protected throughout with an approved, supervised automatic sprinkler system in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems, animal housing facilities shall be permitted to be separated with a 1-hour fire resistance-rated enclosure from the hazardous areas
South Australia, Australia	An open space complying with clause C2.4(a) (Requirements for open spaces and vehicular access) of Volume 1 of the BCA shall be provided around each hay shed, for a distance not less than the maximum hay storage height x 1.5.

5.3 Analysis

5.3.1 *Buildings under 2000m² in floor area*

The BCA under clause C 3.2 protection of openings in external walls, infers that a minimum separation distance of 6m will be required between buildings on the same allotment to minimise the risk of fire spread.

If the buildings are in adjoining lots, then a minimum distance of 3m from the lot boundary must be achieved by both properties and thereby providing a 6m separation between these buildings.

It is our understanding of the intent of the draft QDC Part 3.7 acceptable solution A1 is that these minimum separation requirements for buildings under a floor area of 2000m² and volume of under 12000m³ will still apply.

5.3.2 *Large Isolated Buildings (LIB)*

For buildings that have a floor area of more than 2000m² but not more than 18000m² AND a volume of more than 12000m³ but not more than 108000m³, the proposal to permit Type C construction where within the provisions and intent of QDC Part 3.7 and omit the open space requirement of 18m wide around the building as per BCA clause C 2.3 (a) (i)(B) is noted.

For LIB's the BCA specifically requires open space around the building for two main reasons, they are

1. To provide adequate vehicular access for the fire crew.
2. Aid in minimising the risk of fire spread to adjoining buildings.

5.3.3 *Fire Spread Analysis*

The potential risk of fire spread between buildings is quantified below to further analyse the proposed acceptable solution A1.

Given the wide range of farm building sizes, the below sizes have been assumed for simplification of the analysis. They cover a floor area from 1000 m^2 to 18000 m^2 and a volume from 3000 m^3 to 108000 m^3. Hence encapsulating the sizes of buildings targeted under the acceptable solution A1.

Table 11: Range of farm building sizes

Test	Building size in m Length x width x height	Floor area in m^2	Volume in m^3
1	40m x 25m x 3m	1000 m^2	3000 m^3
2	40m x 25m x 6m	1000 m^2	6000 m^3
3	50m x 40m x 3m	2000 m^2	6000 m^3
4	50m x 40m x 6m	2000 m^2	12000 m^3
5	360m x 50m x 3m	18000 m^2	54000 m^3
6	360m x 50m x 6m	18000 m^2	108000 m^3
7	Ceiling heights of 9m and 12m were further considered to determine height limitations related to travel distance		

The intensity of radiation received by a surface remote from an emitter is calculated using the following equation:

$$\dot{q_R} = \emptyset \varepsilon \sigma (273 + T_e)^4$$

Where:

$\emptyset$ = Configuration factor (value between 0 - 1.0)

ε = Emissivity of emitter and absorptivity of receiving surface (value between 0 and 1.0). Value of 1 used to be conservative in the analysis.

σ = Stefan Boltzmann constant (5.67 X 10^{-11}(kW/m^2/K^4))

Separation distance

It is assumed that these buildings are on fire and the impact of heat radiation on the adjoining property is studied. The separation distances studied are 3m, 6m, 10m, 14m and 18m. Justification for the selection of the distances is as follows:-

1. Separation distance of 3m is selected because the BCA specifies a minimum distance of 3m from a fire source feature. Given the draft QDC part 3.7 aims to omit the requirement of distance separation, the impact of a minimum 3m setback from a boundary is reviewed.
2. Separation distance of 6m is selected since it's the BCA clause C3.2 specified distance between buildings on the same allotment to minimise the risk of fire spread via unprotected openings.
3. Separation distances of 10m and 14m are iterative assumptions made as part of this analysis.
4. Separation distance of 18m is the minimum distance required under BCA clause C 2.3 (a) (i)(B) which the draft QDC Part 3.7 aims to omit.

Temperatures of radiator

In regard to the temperatures used in this study, temperatures of 500 ºC and 800 ºC have been assumed as reasonable design values for fire spread assessment. These temperatures are reflective of a pre flashover and post flashover temperatures respectively. Aljumiah et al estimate in their research have also estimated a temperature in the range of 600-700ºC for compartments. Hence the usage of 500 ºC and 800 ºC is a conservative estimate for pre and post flashover fires.

Acceptance Criteria

The BCA verification method CV1 and CV2 implies that radiation impact on the building from a fire source feature must not exceed 20 kW/m². This intensity relates to ignitability of 'normal' materials such as upholstered furniture and like materials, which is conservative. Hence for this fire spread analysis, this value will be used as the acceptance criteria.

Quantification

The computational tool used for this analysis is FIREWIND – Radiation. A sample calculation is provided below for ease of reference:-

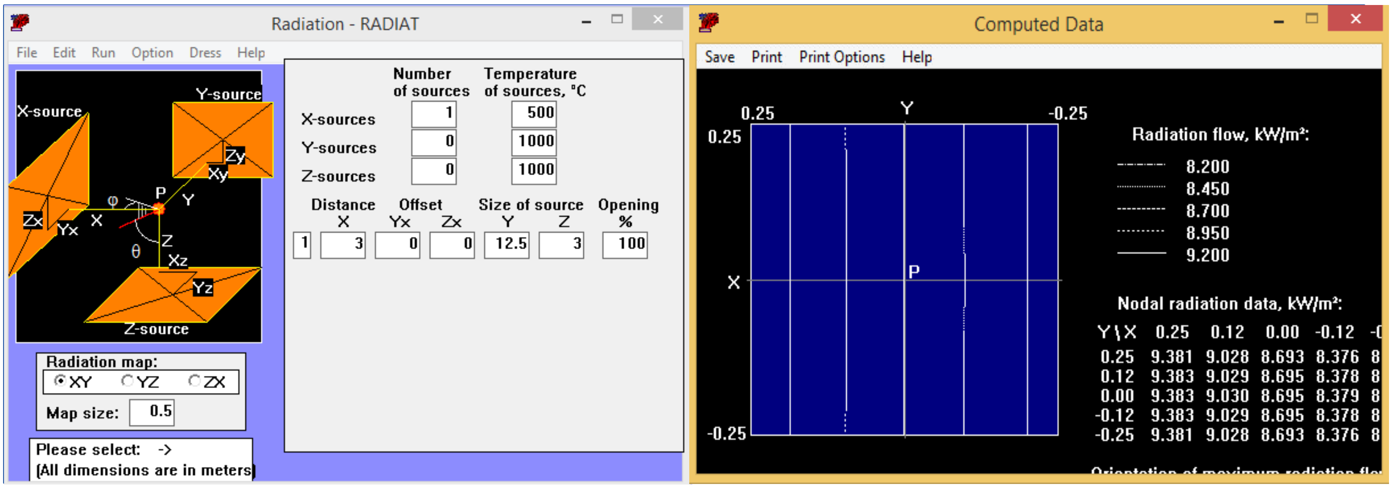


Figure 1: Sample radiation calculation using FIREWIND Program

The below table has been populated based on the above methodology.

Table 12: Summary of Radiation Calculations for a range of farm building sizes

No	Building size in m Length x width x height	Distance from fire source feature	Emitter temperature (assumed) in ºC	Radiator size in m	Calculated heat radiation in kW/m²	Acceptable heat radiation in kW/m²
1	40m x 25m x 3m	3m	500 ºC	12.5m x 3m	8.6 kW/m²	20 kW/m²
2	40m x 25m x 6m	3m	500 ºC	25m x 3m	9.0 kW/m²	20 kW/m²
3	50m x 40m x 3m	3m	500 ºC	20m x 3m	8.9 kW/m²	20 kW/m²
4	50m x 40m x 6m	3m	500 ºC	40m x 3m	9.0 kW/m²	20 kW/m²
5	360m x 50m x 3m	3m	500 ºC	25m x 3m	9.0 kW/m²	20 kW/m²
6	360m x 50m x 6m	3m	500 ºC	50m x 3m	9.0 kW/m²	20 kW/m²
7	40m x 25m x 3m	6m	500 ºC	12.5m x 3m	4.0 kW/m²	20 kW/m²
8	40m x 25m x 6m	6m	500 ºC	25m x 3m	4.7 kW/m²	20 kW/m²

No	Building size in m Length x width x height	Distance from fire source feature	Emitter temperature (assumed) in ºC	Radiator size in m	Calculated heat radiation in kW/m²	Acceptable heat radiation in kW/m²
9	50m x 40m x 3m	6m	500 ºC	20m x 3m	4.5 kW/m²	20 kW/m²
10	50m x 40m x 6m	6m	500 ºC	40m x 3m	4.8 kW/m²	20 kW/m²
11	360m x 50m x 3m	6m	500 ºC	25m x 3m	4.7kW/m²	20 kW/m²
12	360m x 50m x 6m	6m	500 ºC	50m x 3m	4.8 kW/m²	20 kW/m²
13	40m x 25m x 3m	10m	500 ºC	12.5m x 3m	1.9 kW/m²	20 kW/m²
14	40m x 25m x 6m	10m	500 ºC	25m x 3m	2.6 kW/m²	20 kW/m²
15	50m x 40m x 3m	10m	500 ºC	20m x 3m	2.4 kW/m²	20 kW/m²
16	50m x 40m x 6m	10m	500 ºC	40m x 3m	2.8 kW/m²	20 kW/m²
17	360m x 50m x 3	10m	500 ºC	25m x 3m	2.6 kW/m²	20 kW/m²
18	360m x 50m x 6	10m	500 ºC	50m x 3m	2.9 kW/m²	20 kW/m²
19	40m x 25m x 3m	14m	500 ºC	12.5m x 3m	1.0 kW/m²	20 kW/m²
20	40m x 25m x 6m	14m	500 ºC	25m x 3m	1.6 kW/m²	20 kW/m²
21	50m x 40m x 3m	14m	500 ºC	20m x 3m	1.5 kW/m²	20 kW/m²
22	50m x 40m x 6m	14m	500 ºC	40m x 3m	1.9 kW/m²	20 kW/m²
23	360m x 50m x 3	14m	500 ºC	25m x 3m	1.6 kW/m²	20 kW/m²
24	360m x 50m x 6	14m	500 ºC	50m x 3m	2.0 kW/m²	20 kW/m²
25	40m x 25m x 3m	18m	500 ºC	12.5m x 3m	0.6 kW/m²	20 kW/m²
26	40m x 25m x 6m	18m	500 ºC	25m x 3m	1.1 kW/m²	20 kW/m²
27	50m x 40m x 3m	18m	500 ºC	20m x 3m	0.9 kW/m²	20 kW/m²
28	50m x 40m x 6m	18m	500 ºC	40m x 3m	1.4 kW/m²	20 kW/m²
29	360m x 50m x 3	18m	500 ºC	25m x 3m	1.1 kW/m²	20 kW/m²
30	360m x 50m x 6	18m	500 ºC	50m x 3m	1.5 kW/m²	20 kW/m²
31	40m x 25m x 3m	3m	800 ºC	12.5m x 3m	32.2 kW/m²	20 kW/m²
32	40m x 25m x 6m	3m	800 ºC	25m x 3m	33.4 kW/m²	20 kW/m²
33	50m x 40m x 3m	3m	800 ºC	20m x 3m	33.2 kW/m²	20 kW/m²
34	50m x 40m x 6m	3m	800 ºC	40m x 3m	33.5 kW/m²	20 kW/m²
35	360m x 50m x 3m	3m	800 ºC	25m x 3m	33.4 kW/m²	20 kW/m²
36	360m x 50m x 6m	3m	800 ºC	50m x 3m	33.6 kW/m²	20 kW/m²
37	40m x 25m x 3m	6m	800 ºC	12.5m x 3m	15 kW/m²	20 kW/m²
38	40m x 25m x 6m	6m	800 ºC	25m x 3m	17.5 kW/m²	20 kW/m²

No	Building size in m Length x width x height	Distance from fire source feature	Emitter temperature (assumed) in ºC	Radiator size in m	Calculated heat radiation in kW/m²	Acceptable heat radiation in kW/m²
39	50m x 40m x 3m	6m	800 ºC	20m x 3m	17 kW/m²	20 kW/m²
40	50m x 40m x 6m	6m	800 ºC	40m x 3m	18 kW/m²	20 kW/m²
41	360m x 50m x 3	6m	800 ºC	25m x 3m	17.5 kW/m²	20 kW/m²
42	360m x 50m x 6	6m	800 ºC	50m x 3m	18.1 kW/m²	20 kW/m²
43	40m x 25m x 3m	10m	800 ºC	12.5m x 3m	7.1 kW/m²	20 kW/m²
44	40m x 25m x 6m	10m	800 ºC	25m x 3m	9.8 kW/m²	20 kW/m²
45	50m x 40m x 3m	10m	800 ºC	20m x 3m	9.1 kW/m²	20 kW/m²
46	50m x 40m x 6m	10m	800 ºC	40m x 3m	10.7 kW/m²	20 kW/m²
47	360m x 50m x 3	10m	800 ºC	25m x 3m	9.8 kW/m²	20 kW/m²
48	360m x 50m x 6	10m	800 ºC	50m x 3m	10.9 kW/m²	20 kW/m²
49	40m x 25m x 3m	14m	800 ºC	12.5m x 3m	4.0 kW/m²	20 kW/m²
50	40m x 25m x 6m	14m	800 ºC	25m x 3m	6.2 kW/m²	20 kW/m²
51	50m x 40m x 3m	14m	800 ºC	20m x 3m	5.5 kW/m²	20 kW/m²
52	50m x 40m x 6m	14m	800 ºC	40m x 3m	7.2 kW/m²	20 kW/m²
53	360m x 50m x 3	14m	800 ºC	25m x 3m	6.2 kW/m²	20 kW/m²
54	360m x 50m x 6	14m	800 ºC	50m x 3m	7.5 kW/m²	20 kW/m²
55	40m x 25m x 3m	18m	800 ºC	12.5m x 3m	2.5 kW/m²	20 kW/m²
56	40m x 25m x 6m	18m	800 ºC	25m x 3m	4.2 kW/m²	20 kW/m²
57	50m x 40m x 3m	18m	800 ºC	20m x 3m	3.7 kW/m²	20 kW/m²
58	50m x 40m x 6m	18m	800 ºC	40m x 3m	5.3 kW/m²	20 kW/m²
59	360m x 50m x 3	18m	800 ºC	25m x 3m	4.2 kW/m²	20 kW/m²
60	360m x 50m x 6	18m	800 ºC	50m x 3m	5.6 kW/m²	20 kW/m²

The above tables are graphed for ease of representation.

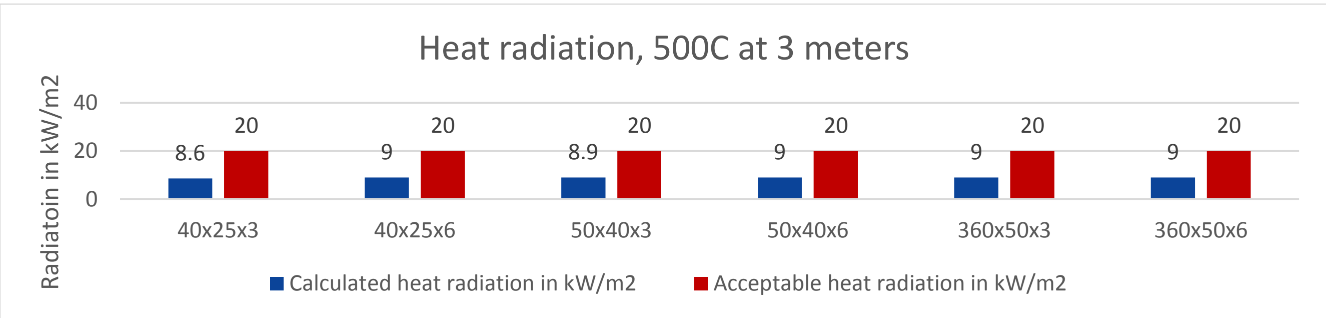


Figure 2: Heat radiation, 500 °C at 3 meters

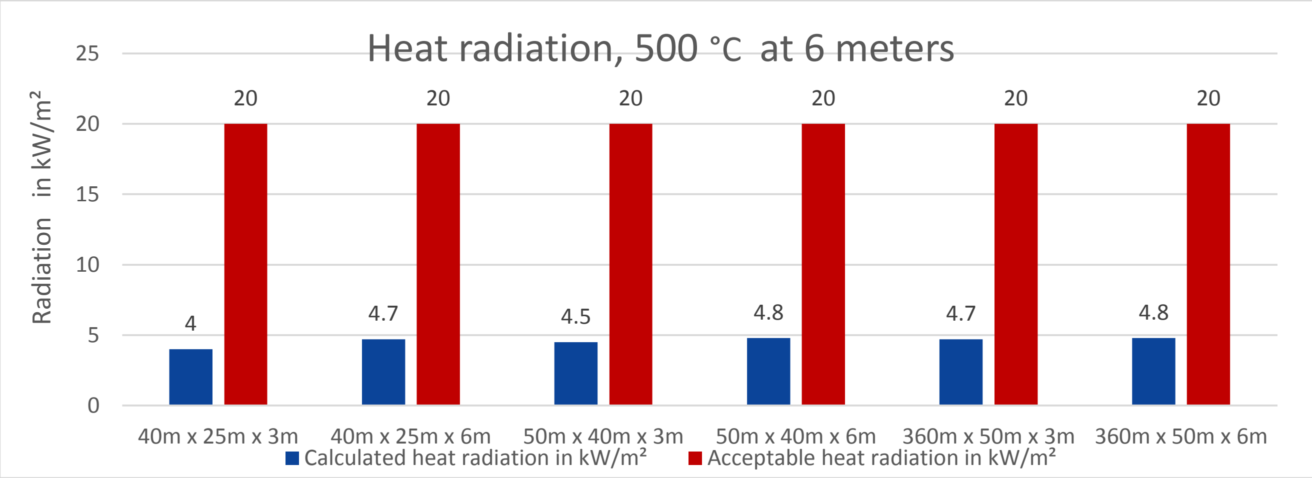


Figure 3: Heat radiation, 500°C at 6 meters

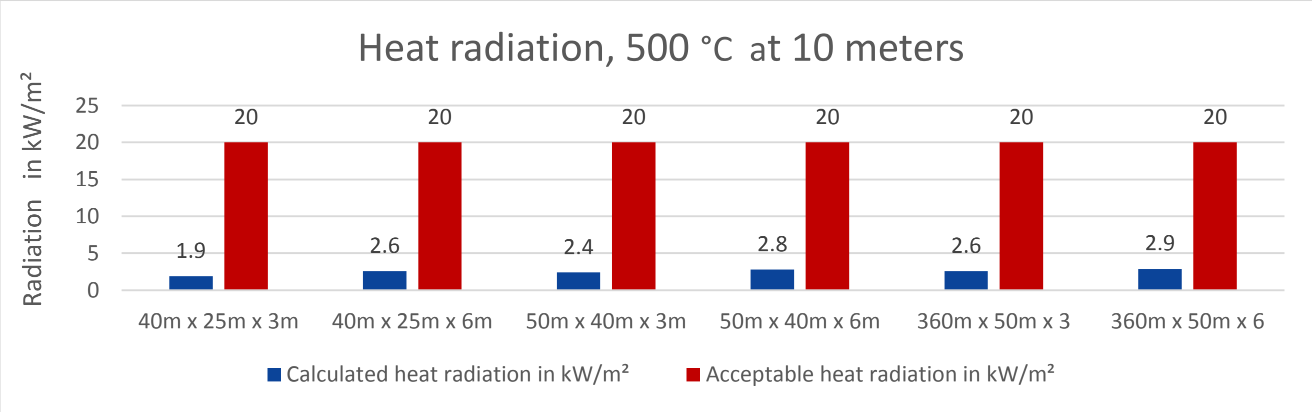


Figure 4: Heat radiation, 500°C at 10 meters

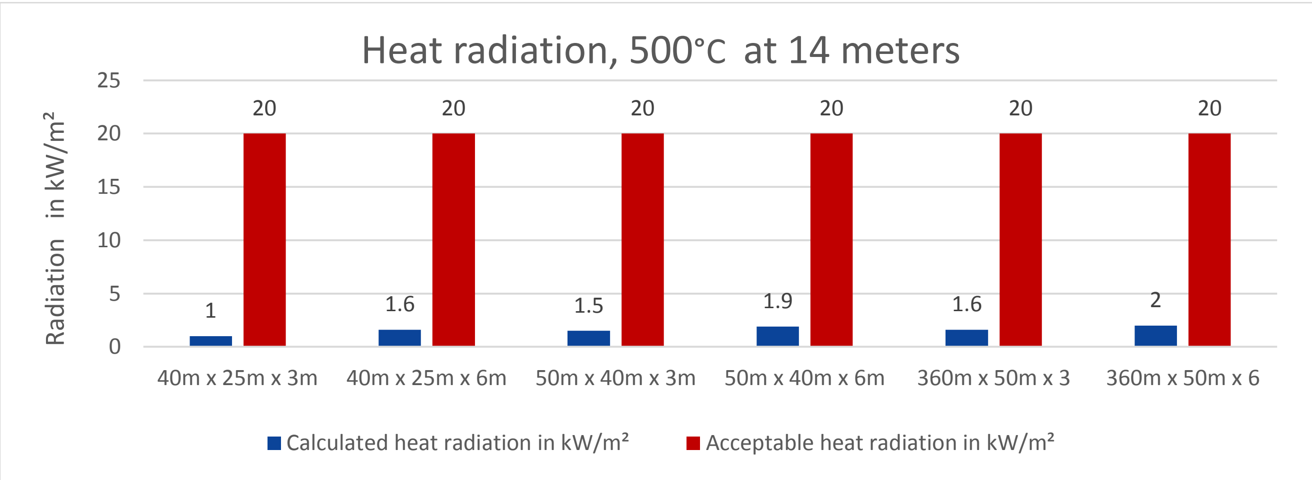


Figure 5: Heat radiation, 500°C at 14 meters

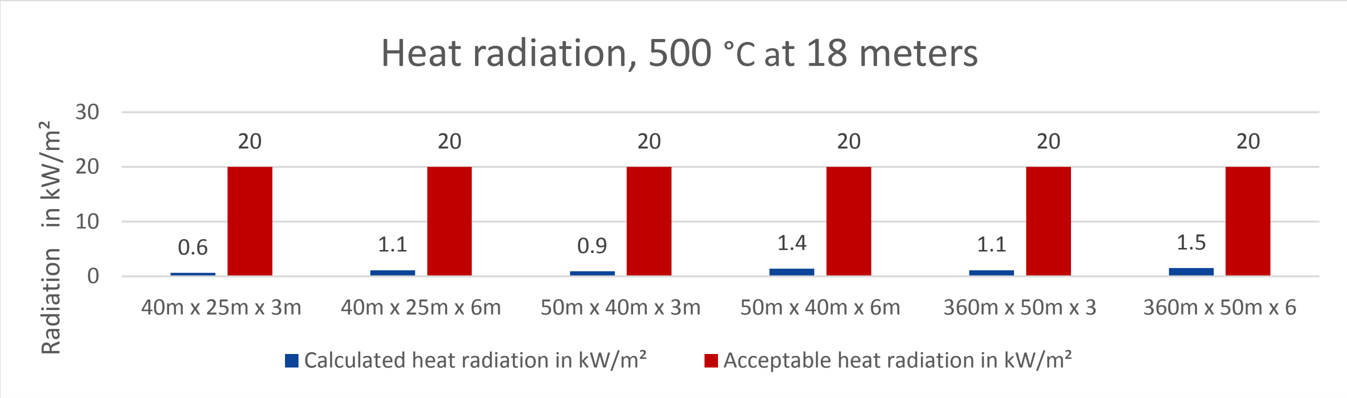


Figure 6: Heat radiation, 500°C at 18 meters

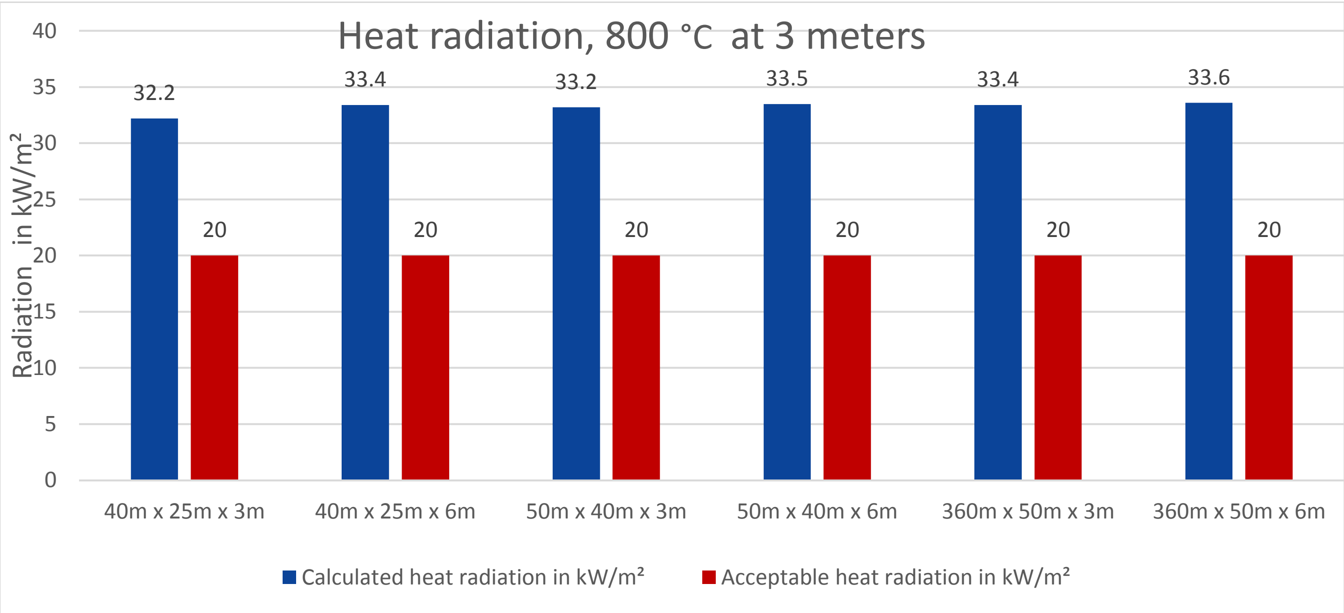


Figure 7: Heat radiation, 800°C at 3 meters

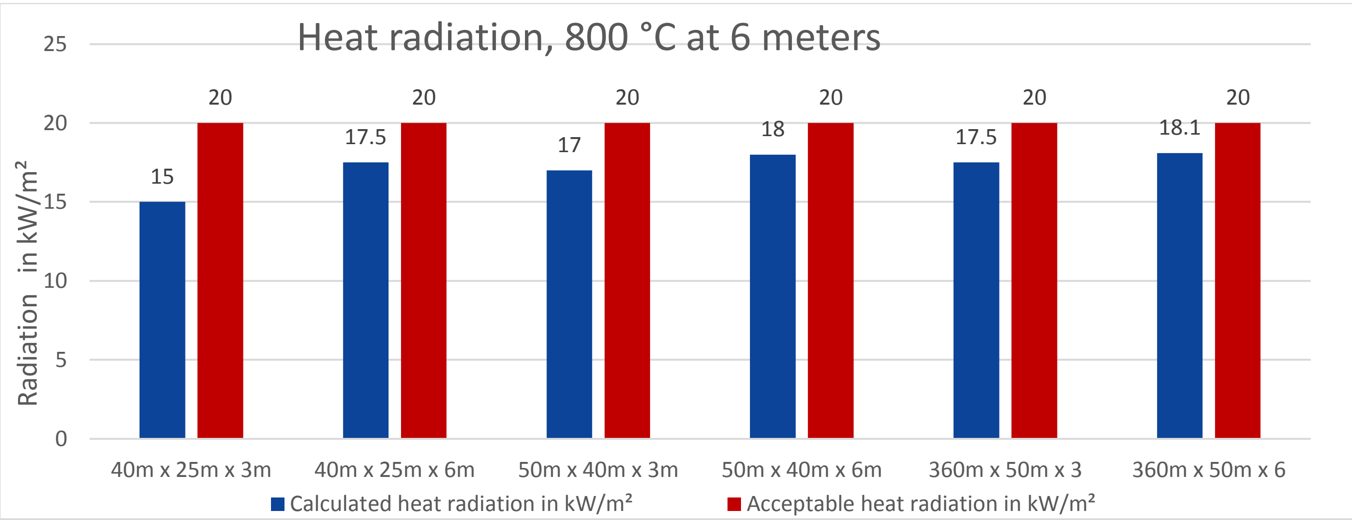


Figure 8: Heat radiation, 500°C at 6 meters

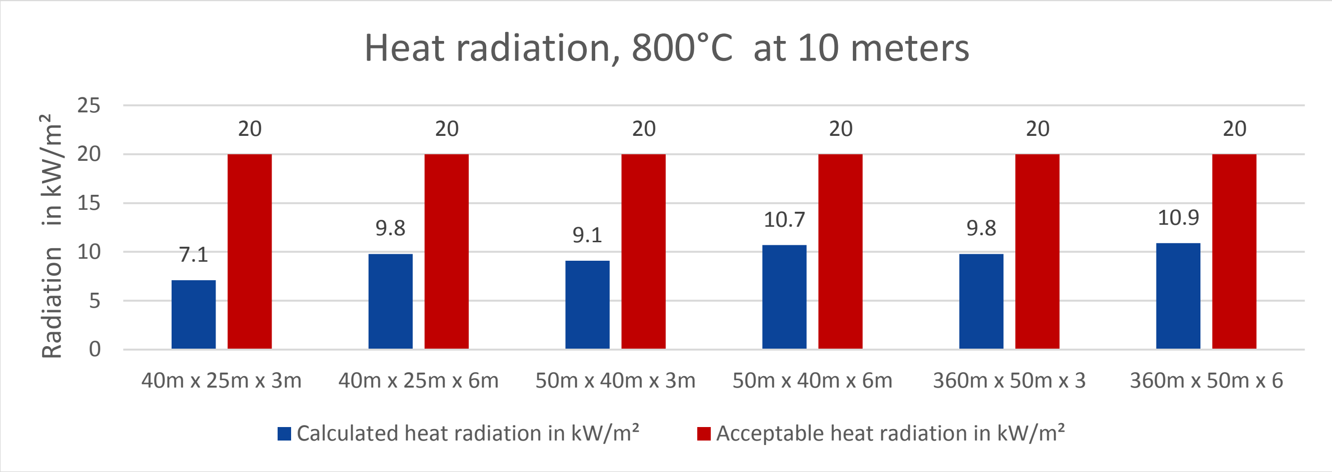


Figure 9: Heat radiation, 800°C at 10 meters

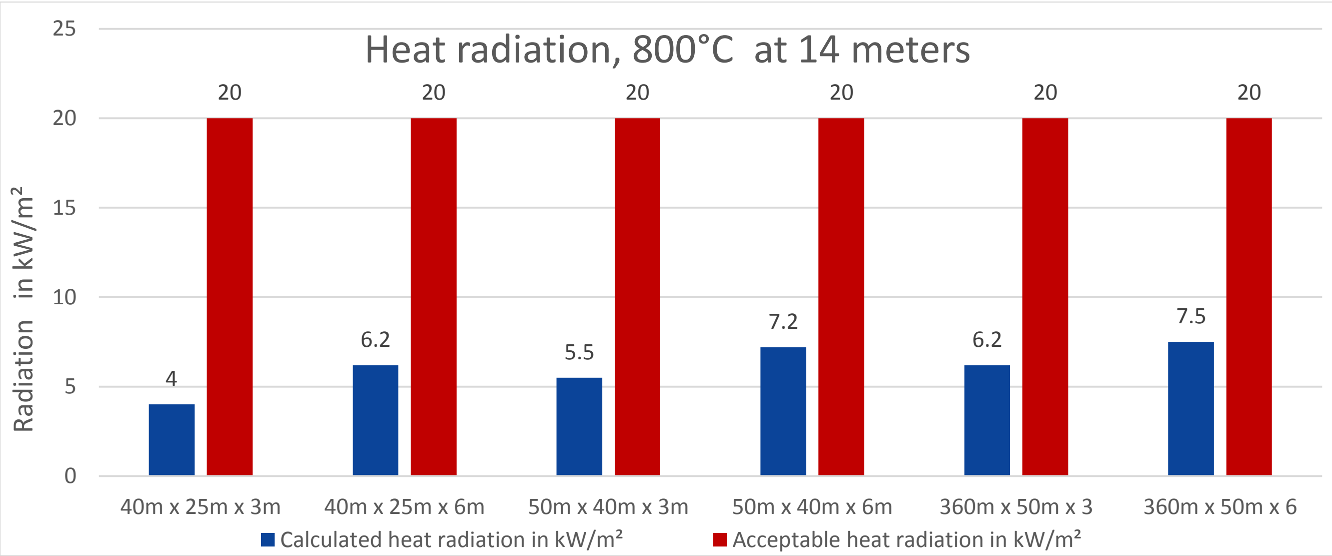


Figure 10: Heat radiation, 800°C at 14 meters

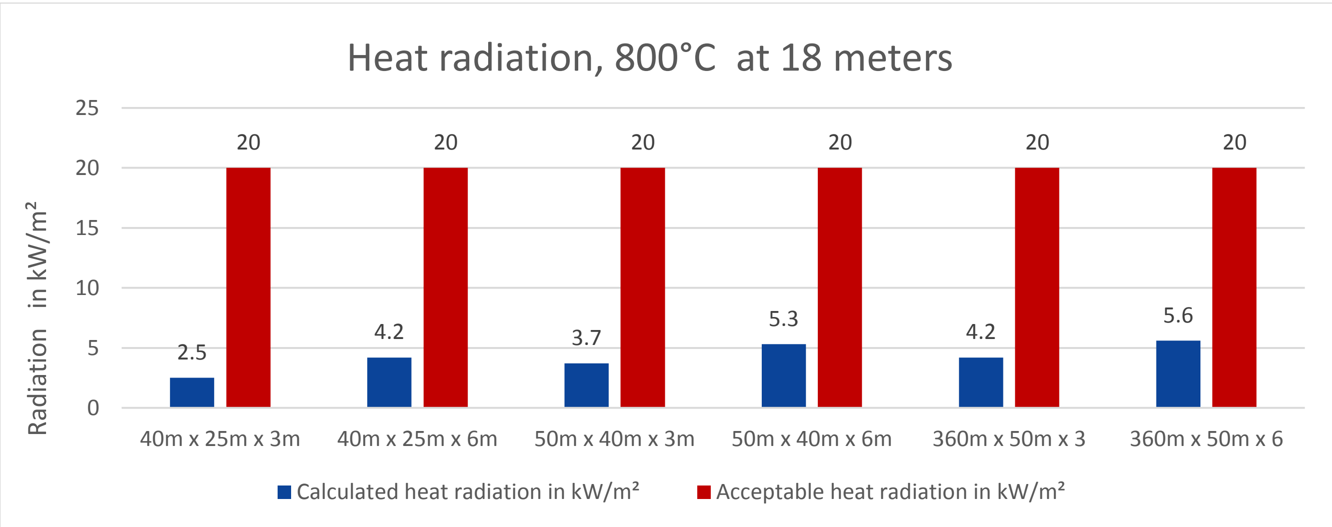


Figure 11: Heat radiation, 800°C at 18 meters

The above graphs show that in certain circumstances the heat radiation can potentially exceed 20kW/m² and thereby cause fire spread.

5.4 Conclusion

From the above analysis it is evident that to minimise the potential risk of fire spread between buildings, a minimum separation distance between buildings must be specified.

Hence the proposal under QDC part 3.7 acceptable solution 1 to omit the separation distances as outlined in BCA clause C 2.3 (a) (i) (B) cannot be supported and hence refuted. The key reasons being:-

- Fire spread between buildings would be likely to occur which will cause an increased risk to occupant life safety, fire crew safety and property.
- Due to the lack of separation distances, the fire crew intervention of a fire event will be significantly hindered. This in turn will cause an increased risk to the fire crew attending to a farm building fire.

Based on the above analysis, it is our view that a minimum separation distance of 6m would be necessary to minimise the risk of fire spread and also facilitate fire crew firefighting activities.

The below figure illustrates our view:-

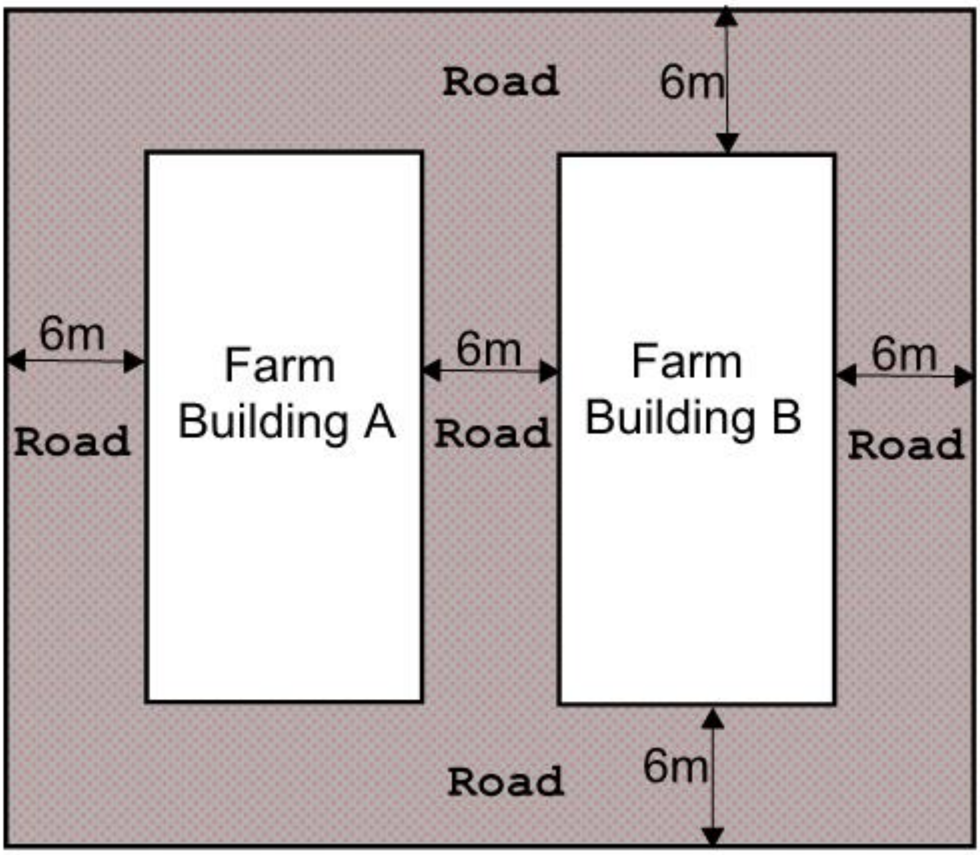


Figure 12: Minimum separation distance of 6m would be necessary to minimise the risk of fire spread

6 A2 Smoke Hazard Management

6.1 Purpose

The purpose of smoke hazard management systems (smoke control measures) in buildings is to allow sufficient evacuation time for the occupants under fire and smoke conditions. The intent of the BCA is to specify requirements for minimising the smoke risks.

6.2 Analysis Limited to 1000m^2 and 2000m^2 Buildings

The analysis considers a floor area of a farm buildings typically up to 2000m^2. Due to limitations in CFAST zone modelling, maximum floor area of 2000m^2 has been used.

6.2.1 *Design Fire Size Determination*

It is proposed to define the fire growth rate and development as a quadratic equation proportional to time squared as shown below.

$$Q = \left({}^{t}/_{k} \right)^{2} \quad \text{or} \quad Q = \alpha t^{2}$$

Where:			
	Q	is the rate of heat release	(kW)
	k	is the constant fire growth parameter	(sec/(kW)$^{0.5}$)
	α	is the fire intensity coefficient	(kW/s^2)
	t	is the time from ignition of the fire	(Seconds)

Table 13 is extracted from the Fire Engineering Design Guide 'Third Edition' [5] and provides typical growth rates for design fires:

Table 13: Fire Growth Rate

Fire growth Rate	Growth Time to 1MW k (sec)	Fire Intensity Coefficient α (kW/s^2)	Typical Real Fire
Slow	600	0.00293	Densely packed wood products
Medium	300	0.0117	Solid Wooden furniture such as desks Individual furniture items with small amounts of plastics
Fast	150	0.0466	High stacked wood pallets Cartons on pallets Some upholstered furniture
Ultra-Fast	75	0.1874	Upholstered furniture High stacked plastic materials Thin wood furniture such as wardrobes

All four growth rates are analysed in this document as part of this study. To provide perspective on growth rates, the below information is provided:-

The National Fire Protection Association Standard NFPA 92B 'Guide for Smoke Management Systems in Malls, Atria and Large Areas' [19] provides the following information on the appropriate t-squared approximations to real fires:

- Wood pallets stacked 4.8m high – fast rate of fire growth
- Paper products, densely packed in cartons, rack storage, 6m high – medium to fast rate of fire growth
- Cartons on pallets, rack storage, 4.5m to 9.1m high – medium to fast rate of fire growth

6.2.2 *CFAST Input Parameters*

Below a table of the input parameters used in CFAST are presented. Parameters that are not presented below were assumed to the default inputs in CFAST.

Table 14: CFAST Inputs for floor area of 1000m²

Parameter	Scenario 1-8	Scenario 9-16	Scenario 17-24	Scenario 25-32
Simulation Time	1800 s	1800 s	1800 s	1800 s
Room Dimensions (WxDxH)	40m x 25m x 3m	40m x 25m x 3m	40m x 25m x 3m	40m x 25m x 3m
Ceiling Heights	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height ■ Open walled with 12m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height ■ Open walled with 12m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height ■ Open walled with 12m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height ■ Open walled with 12m ceiling height
Growth Rate	Slow t^2	Medium t^2	Fast t^2	Ultrafast t^2
Plume Model	Heskestad's	Heskestad's	Heskestad's	Heskestad's
Radiative Fraction [20]	0.3	0.3	0.3	0.3
Assumed ceiling and Wall Material Properties (assumed based on the site inspection undertaken by WSP Buildings to prepare this report)	Steel and Concrete	Steel and Concrete	Steel and Concrete	Steel and Concrete
Heat of Combustion [21]	25000KJ/kg	25000KJ/kg	25000KJ/kg	25000KJ/kg

Table 15: CFAST Inputs for floor area of 2000m²

Parameter	Scenario 33-40	Scenario 41-48	Scenario 49-56	Scenario 57-64
Simulation Time	1800 s	1800 s	1800 s	1800 s
Room Dimensions (WxDxH)	50m x 40m x 3m	50m x 40m x 3m	50m x 40m x 3m	50m x 40m x 3m
Ceiling Heights	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height	■ 3m ■ 6m ■ 9m ■ 12m ■ Open walled with 3m ceiling height ■ Open walled with 6m ceiling height ■ Open walled with 9m ceiling height

Parameter	Scenario 33-40	Scenario 41-48	Scenario 49-56	Scenario 57-64
	▪ Open walled with 12m ceiling height	▪ Open walled with 12m ceiling height	▪ Open walled with 12m ceiling height	▪ Open walled with 12m ceiling height
Growth Rate	Slow t^2	Medium t^2	Fast t^2	Ultrafast t^2
Plume Model	Heskestad's	Heskestad's	Heskestad's	Heskestad's
Radiative Fraction	0.3	0.3	0.3	0.3
Ceiling and Wall Material Properties	Steel and Concrete	Steel and Concrete	Steel and Concrete	Steel and Concrete
Heat of Combustion	25000KJ/kg	25000KJ/kg	25000KJ/kg	25000KJ/kg

6.2.3 ASET Determination

Based on the IFEG, tenability for occupant life safety is assessed on the following conditions not endangering human life:

- Temperature
- Level of visibility

For the purpose of this project, the limits of acceptability will be as follows:

<u>Occupant Tenability Criteria 1 - Smoke Layer ≥ 2.1m</u>

Fire Engineering Design Guide [13] suggests that the acceptance radiant heat from the upper smoke layer at the head height (2.1m above the floor level) should not exceed 2.5kW/m^2 which corresponds to the average upper smoke temperature of approx. 200˚C). Therefore, the adopted acceptance criteria are:

- When smoke layer height ≥ 2.1m, radiant heat at head height (2.1m AFFL) shall ≤ 2.5kW/m^2 (or ≤ 200˚C)

<u>Occupant Tenability Criteria 2 - Smoke Layer < 2.1m</u>

The maximum tolerance temperature of air where people are exposed within the smoke layer (i.e. smoke layer height less than 2.1 m) is set to be 60˚C. For air temperatures above 60˚C and up to 100˚C, the time to incapacitation will be determined by the SFPE Handbook Fractional Incapacitation Dose Model.

Generally, the visibility must not be less than 10m for large rooms in the main egress routes to enable the escape route to be determined which would provide reasonable way finding and avoid toxicity problems. In small rooms, the visibility can be reduced to not less than 5m.

Therefore, the adopted acceptance criteria are:

- For the smoke layer height < 2.1m, the smoke temperature shall be ≤ 60˚C, and
- Generally, the visibility in main evacuation routes shall be greater or equal to 10 m for large rooms

6.2.4 Acceptance Criteria for Fire Crews (As Applied to Alternative Solutions)

For the purpose of this section, it is assumed that attending fire crews will be provided with adequate water supply to fight a fire, whilst occupants of the building will initiate avoidance to the effects of a fire and initiate safe evacuation.

For alternative solutions to the BCA prescriptive provisions are considered, the anticipated conditions for fire brigade intervention should be considered in consultation with the local fire emergency service.

Where applicable alternative solution assessments undertaken for fire brigade intervention is normally associated with the development and agreement of a Fire Brigade Intervention Model (FBIM)

The acceptance criteria (at height of 1.5m above floor level) for fire brigade intervention are extracted from the Queensland Fire and Rescue Service "Guide to Referral of Alternative Solutions" and which are as follows:

Routine Condition

Elevated temperatures, but not direct thermal radiation.

» Maximum Time: 25 minutes
» Maximum Air Temperature: 100°C (in lower layer)
» Maximum Radiation: 1kW/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°C (in lower layer)
» 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: 160°C (in lower layer)
» Maximum Air Temperature: 280°C (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: > 235°C (in lower layer)
» Radiation: > 10 kW/m^2

Figure 13: CFAST Zone Model View

Visibility is not an acceptance criteria set by the QFES Guide to the Referral of Alternative Solutions for hazardous conditions, however where alternative solutions are applied, it should be considered if requested by the QFES Building Approval Officer (assuming only where all fire safety systems are operative).

It should be noted that where a building is constructed to the BCA deemed to satisfy prescriptive provisions and assuming that DTS travel distances are applied, the acceptance criteria for fire brigade intervention does not currently form part of the formal approvals process.

6.2.5 *Zone Modelling Methodology and Limitations*

Zone model computational fire simulations are utilized to determine the conjectural fire scenarios under investigation. In this instance it is a limited analysis which relates to the Terms of Reference associated with this report.

In terms of smoke layer and temperature development from a fire at different areas, CFAST modellings were adopted to estimate the Available Safe Egress Time (ASET) for evacuation in a farm building.

A zone model fire scenario for floor areas of 1000m^2 and 2000m^2 with various ceiling heights were modelled respectively as generically illustrated in this report. It should be noted that, due to the limitations associated with zone modelling, the ceiling heights nominated is assumed as a flat ceiling in the models, whereas buildings would be expected to be constructed with pitched roof profiles.

The modelled ceiling heights are therefore assumed to be a volumetric average between eaves and pitch to present different probabilities for averaged heights to underside of roof.

The models associated with an "open-walled building" are based on the QDC Part 3.7 definition, which states that a building can be defined as such if at least a third of the perimeter of the building has no walls.

Where open-walled buildings are modelled, a full height perimeter opening of 43m and 60m respectively for 1000m^2 and 2000m^2 buildings are assumed. This assumed opening is subjective and may not transfer to the functional use of some buildings.

This opinion is raised because although permanent openings may be constructed initially, it could present a circumstance that they may be applied in conjunction with solid fabric or the like covers which are managed on the site to control adverse external conditions such as wind, daylight and/ or environmental temperature. This was evident in the visit to a chicken farm in the Toowoomba region that was undertaken by WSP for preparation of this report.

The benefit of constructed openings to the buildings may therefore not translate to the advantage for smoke venting and internal conditions in the event of a fire, if openings are partly or totally closed at intervals.

It should also be noted that the reference to “open walled”, or which can also be referred to as “open sides” is also subjective due to various probabilities of the openings in construction and interpretation of construction detail.

Openings may be less than full face height to underside of the eaves due to down-turns under the eaves. This possibility for variances with as-built circumstances relating to “open-walled” buildings not construing full sidewall openings, will have an impact on smoke migration and venting, which should be taken into account.

It is therefore considered that considerations for assessment of “open-walled buildings” should take temporary “normal-in-use” covers and variables in sidewall opening height into account since it would not necessarily be an advantage for design purposes to assume the openings are always fully open.

It should also be noted that a square building profile is modelled commensurate with zone model operating parameters which are not highly sensitive to particular shape associated with the internal volume, hence ‘ideal’ dynamics with respect to building shapes are involved when zone modelling is applied.

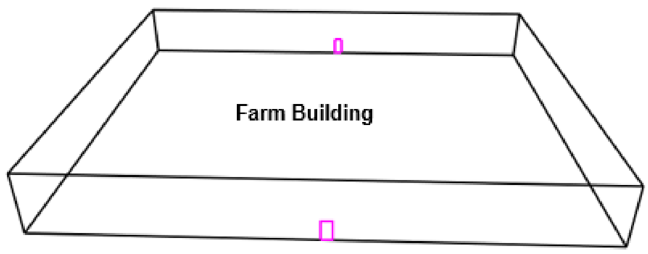


Figure 14: CFAST Zone Model View

6.3 CFAST Results

An analysis using CFAST was undertaken to determine the effect of various t^2 fire scenarios in the farm building as summarised in Table 14 and Table 15.

The results from the CFAST output graphs illustrated within this section after Table 16, indicate that smoke layer temperatures and visibility within the farm building remain mostly tenable for a period of time to allow safe evacuation of the occupants, however there are some failures indicative of the lower ceiling heights.

Table 16 below also contains the results in smoke layer temperature results commensurate with approximate limiting exposure levels for fire brigade intervention within the building structure, which is to be considered in conjunction with consultations with the Approving Authority when one or more alternative solutions are applied.

However, since it is plausible that fire brigade is likely arriving at a remote scenario only after 30 minutes, it is our view that it would not be feasible to have a building solution associated with QDC Part 3.7, to be inclusive of systems to cater for internal environmental conditions (tenability) for fire brigade intervention, as would be the case for standard BCA deemed to satisfy building solutions.

Clarification:

With reference to the CFAST modelling results in the table below in relation to the fire graphical illustrations which follow, the limiting acceptance criteria smoke layer height is considered in conjunction with the acceptance criteria for limiting layer temperature at the time when the smoke layer drops below at 2.1m above floor level, for occupant safety. The time at which the first of these two limiting criterion are realised, is subsequently reflected as the result ASET t = seconds. These results are subsequently measured against assumed required egress time as determined and summarised in follow-on **Section 7** below.

The reason for this Section 6 being addressed for Smoke Hazard Management prior to assessment for Access and Egress, is that it relates to the sequence in QDC Part 3.7. P2 - Smoke Hazard Management. It is therefore necessary to read this section in conjunction with Section 7 “Access and Egress”.

The column in the table below relating to limiting criteria as set out for a Fire Brigade Intervention Model (FBIM) is informative only for consideration where alternative solutions are applied. Where a building is constructed to the BCA deemed to satisfy prescriptive provisions and assuming that BCA - DTS travel distances are applied, the acceptance criteria for fire brigade intervention does not currently form part of the formal approvals process.

Table 16: Fire Scenarios and CFAST Results (Related to Nominated Acceptance Criteria)

Fire Scenario	Design Fire	CFAST Result Upper Layer Smoke Temperature Reaches 200°C OR 2.5kW/m2 at ≥ 2.1m AFFL	CFAST Result Smoke Layer Height Reaching ≤ 2.1m AFFL	SELECTED Available Safe Egress Time (ASET)	FBIM Criteria 1 (C1): Smoke layer height ≤ 1.5m at temperature ≥ 120°C (OR) WORST CASE SELECTED Criteria 2 (C2): Smoke layer height ≥ 1.5m at temperature ≥ 200°C
Farm Building with floor area of 1000m^2					
Scenario 1	Slow t^2 Fire with 3m ceiling height	1230 sec	620 sec	**620 sec**	C1 = 850 sec
Scenario 2	Slow t^2 Fire with 6m ceiling height	1470 sec	850 sec	**850 sec**	C1 = 1050 sec
Scenario 3	Slow t^2 Fire with 9m ceiling height	1660 sec	910 sec	**910 sec**	C1 = 1210 sec
Scenario 4	Slow t^2 Fire with 12m ceiling height	>1800 sec	940 sec	**940 sec**	C1 = 1350 sec
Scenario 5	Slow t^2 Fire open walled with 3m ceiling height	1150 sec	>1800 sec	**1150 sec**	C2 = 1150 sec
Scenario 6	Slow t^2 Fire open walled with 6m ceiling height	1730 sec	>1800 sec	**1730 sec**	C2 = 1730 sec
Scenario 7	Slow t^2 Fire open walled with 9m ceiling height	>1800 sec	>1800 sec	**>1800 sec**	C2 >1800 sec
Scenario 8	Slow t^2 Fire open walled with 12m ceiling height	>1800 sec	>1800 sec	**>1800 sec**	C2 > 1800 sec
Scenario 9	Medium t^2 Fire with 3m ceiling height	640 sec	400 sec	**400 sec**	C1 = 540 sec
Scenario 10	Medium t^2 Fire with 6m ceiling height	790 sec	570 sec	**570 sec**	C1 = 640 sec
Scenario 11	Medium t^2 Fire with 9m ceiling height	910 sec	610 sec	**610 sec**	C1 = 680 sec
Scenario 12	Medium t^2 Fire with 12m ceiling height	1020 sec	640 sec	**640 sec**	C1 = 690 sec

Fire Scenario	Design Fire	CFAST Result Upper Layer Smoke Temperature Reaches 200°C OR 2.5kW/m2 at ≥ 2.1m AFFL	CFAST Result Smoke Layer Height Reaching ≤ 2.1m AFFL	SELECTED Available Safe Egress Time (ASET)	FBIM Criteria 1 (C1): Smoke layer height ≤ 1.5m at temperature ≥ 120°C (OR) WORST CASE SELECTED Criteria 2 (C2): Smoke layer height ≥ 1.5m at temperature ≥ 200°C
Scenario 13	Medium t^2 Fire open walled with 3m ceiling height	600 sec	>1800 sec	**600 sec**	C2 = 600sec to 1800sec
Scenario 14	Medium t^2 Fire open walled with 6m ceiling height	890 sec	>1800 sec	**890 sec**	C2 = 890sec to 1800sec
Scenario 15	Medium t^2 Fire open walled with 9m ceiling height	1260 sec	>1800 sec	**1260 sec**	C2 = 1260sec to 1800sec
Scenario 16	Medium t^2 Fire open walled with 12m ceiling height	1670 sec	>1800 sec	**1670 sec**	C2 = 1670sec to 1800sec
Scenario 17	Fast t^2 Fire with 3m ceiling height	340 sec	270sec	**270 sec**	C1 = 350 sec
Scenario 18	Fast t^2 Fire with 6m ceiling height	450 sec	380 sec	**380 sec**	C1 = 430 sec
Scenario 19	Fast t^2 Fire with 9m ceiling height	530 sec	410 sec	**410 sec**	C1 = 450 sec
Scenario 20	Fast t^2 Fire with 12m ceiling height	590 sec	430 sec	**430 sec**	C1 = 460 sec
Scenario 21	Fast t^2 Fire open walled with 3m ceiling height	310 sec	1020 sec	**310 sec**	C2 = 310sec – 1800sec
Scenario 22	Fast t^2 Fire open walled with 6m ceiling height	460 sec	>1800 sec	**460 sec**	C2 = 460sec – 1800sec
Scenario 23	Fast t^2 Fire open walled with 9m ceiling height	650 sec	>1800 sec	**650 sec**	C2 = 650sec – 1800sec
Scenario 24	Fast t^2 Fire open walled with 12m ceiling height	850 sec	>1800 sec	**850 sec**	C2 = 850sec – 1800sec
Scenario 25	Ultrafast t^2 Fire with 3m ceiling height	180 sec	180 sec	**180 sec**	C1 = 220 sec
Scenario 26	Ultrafast t^2 Fire with 6m ceiling height	260 sec	250 sec	**250 sec**	C1 = 280 sec
Scenario 27	Ultrafast t^2 Fire with 9m ceiling height	310 sec	280 sec	**280 sec**	C1 = 300 sec
Scenario 28	Ultrafast t^2 Fire with 12m ceiling height	350 sec	300 sec	**300 sec**	C1 = 360 sec

Fire Scenario	Design Fire	CFAST Result Upper Layer Smoke Temperature Reaches 200°C OR 2.5kW/m2 at ≥ 2.1m AFFL	CFAST Result Smoke Layer Height Reaching ≤ 2.1m AFFL	SELECTED Available Safe Egress Time (ASET)	FBIM Criteria 1 (C1): Smoke layer height ≤ 1.5m at temperature ≥ 120°C (OR) WORST CASE SELECTED Criteria 2 (C2): Smoke layer height ≥ 1.5m at temperature ≥ 200°C
Scenario 29	Ultrafast t^2 Fire open walled with 3m ceiling height	160 sec	510 sec	**160 sec**	C2 = 160sec – 1800sec
Scenario 30	Ultrafast t^2 Fire open walled with 6m ceiling height	240 sec	>1800 sec	**240 sec**	C2 = 240sec – 1800sec
Scenario 31	Ultrafast t^2 Fire open walled with 9m ceiling height	330 sec	>1800 sec	**330 sec**	C2 = 330sec – 1800sec
Scenario 32	Ultrafast t^2 Fire open walled with 12m ceiling height	440 sec	>1800 sec	**440 sec**	C2 = 440sec – 1800sec
Farm Building with floor area of 2000m²					
Scenario 33	Slow t^2 Fire with 3m ceiling height	1650 sec	860 sec	**860 sec**	C1 = 1140 sec
Scenario 34	Slow t^2 Fire with 6m ceiling height	>1800 sec	1190 sec	**1190 sec**	C1 = 1360 sec
Scenario 35	Slow t^2 Fire with 9m ceiling height	>1800 sec	1270 sec	**1270 sec**	C1 = 1410 sec
Scenario 36	Slow t^2 Fire with 12m ceiling height	>1800 sec	1320 sec	**1320 sec**	C1 = 1440 sec
Scenario 37	Slow t^2 Fire open walled with 3m ceiling height	1530 sec	>1800 sec	**1530 sec**	C2 = 1530sec – 1800sec
Scenario 38	Slow t^2 Fire open walled with 6m ceiling height	>1800 sec	>1800 sec	**>1800 sec**	C2 = >1800 sec
Scenario 39	Slow t^2 Fire open walled with 9m ceiling height	>1800 sec	>1800 sec	**>1800 sec**	C2 = >1800 sec
Scenario 40	Slow t^2 Fire open walled with 12m ceiling height	>1800 sec	>1800 sec	**>1800 sec**	C2 = >1800 sec
Scenario 41	Medium t^2 Fire with 3m ceiling height	860 sec	550 sec	**550 sec**	C1 = 730 sec
Scenario 42	Medium t^2 Fire with 6m ceiling height	1040 sec	790 sec	**790 sec**	C1 = 880 sec
Scenario 43	Medium t^2 Fire with 9m ceiling height	1180 sec	850 sec	**850 sec**	C1 = 930 sec

Fire Scenario	Design Fire	CFAST Result Upper Layer Smoke Temperature Reaches 200°C OR 2.5kW/m2 at ≥ 2.1m AFFL	CFAST Result Smoke Layer Height Reaching ≤ 2.1m AFFL	SELECTED Available Safe Egress Time (ASET)	FBIM Criteria 1 (C1): Smoke layer height ≤ 1.5m at temperature ≥ 120°C (OR) WORST CASE SELECTED Criteria 2 (C2): Smoke layer height ≥ 1.5m at temperature ≥ 200°C
Scenario 44	Medium t^2 Fire with 12m ceiling height	1300 sec	890 sec	**890 sec**	C1 = 950 sec
Scenario 45	Medium t^2 Fire open walled with 3m ceiling height	790 sec	>1800 sec	**790 sec**	C2 = 790sec – 1800sec
Scenario 46	Medium t^2 Fire open walled with 6m ceiling height	1070 sec	>1800 sec	**1070 sec**	C2 = 1070sec – 1800sec
Scenario 47	Medium t^2 Fire open walled with 9m ceiling height	1430 sec	>1800 sec	**1430 sec**	C2 = 1430sec – 1800sec
Scenario 48	Medium t^2 Fire open walled with 12m ceiling height	1800 sec	>1800 sec	**1800 sec**	C2 = >1800 sec
Scenario 49	Fast t^2 Fire with 3m ceiling height	460 sec	360 sec	**360 sec**	C1 = 460 sec
Scenario 50	Fast t^2 Fire with 6m ceiling height	580 sec	520 sec	**520 sec**	C1 = 570 sec
Scenario 51	Fast t^2 Fire with 9m ceiling height	670 sec	570 sec	**570 sec**	C1 = 610 sec
Scenario 52	Fast t^2 Fire with 12m ceiling height	750 sec	600 sec	**600 sec**	C1 = 630 sec
Scenario 53	Fast t^2 Fire open walled with 3m ceiling height	410 sec	>1800 sec	**410 sec**	C2 = 410sec – 1800sec
Scenario 54	Fast t^2 Fire open walled with 6m ceiling height	550 sec	>1800 sec	**550 sec**	C2 = 550sec – 1800sec
Scenario 55	Fast t^2 Fire open walled with 9m ceiling height	740 sec	>1800 sec	**740 sec**	C2 = 740sec – 1800sec
Scenario 56	Fast t^2 Fire open walled with 12m ceiling height	940 sec	>1800 sec	**940 sec**	C2 = 940sec – 1800sec
Scenario 57	Ultrafast t^2 Fire with 3m ceiling height	240 sec	230 sec	**230 sec**	C1 = 300 sec
Scenario 58	Ultrafast t^2 Fire with 6m ceiling height	320 sec	340 sec	**320 sec**	C1 = 370 sec
Scenario 59	Ultrafast t^2 Fire with 9m ceiling height	390 sec	380 sec	**380 sec**	C1 = 400 sec

Fire Scenario	Design Fire	CFAST Result Upper Layer Smoke Temperature Reaches 200°C OR 2.5kW/m2 at ≥ 2.1m AFFL	CFAST Result Smoke Layer Height Reaching ≤ 2.1m AFFL	SELECTED Available Safe Egress Time (ASET)	FBIM Criteria 1 (C1): Smoke layer height ≤ 1.5m at temperature ≥ 120ºC (OR) WORST CASE SELECTED Criteria 2 (C2): Smoke layer height ≥ 1.5m at temperature ≥ 200ºC
Scenario 60	Ultrafast t^2 Fire with 12m ceiling height	440 sec	400 sec	**400 sec**	C1 = 420 sec
Scenario 61	Ultrafast t^2 Fire open walled with 3m ceiling height	220 sec	>1800 sec	**220 sec**	C2 = 220sec – 1800sec
Scenario 62	Ultrafast t^2 Fire open walled with 6m ceiling height	290 sec	>1800 sec	**290 sec**	C2 = 290sec – 1800sec
Scenario 63	Ultrafast t^2 Fire open walled with 9m ceiling height	380 sec	>1800 sec	**380 sec**	C2 = 380sec – 1800sec
Scenario 64	Ultrafast t^2 Fire open walled with 12m ceiling height	480 sec	>1800 sec	**480 sec**	C2 = 480sec – 1800sec

6.3.1 *CFAST Modelling Illustrations*

CFAST modelling results associated with the table above are reflected in the illustrations which follow:

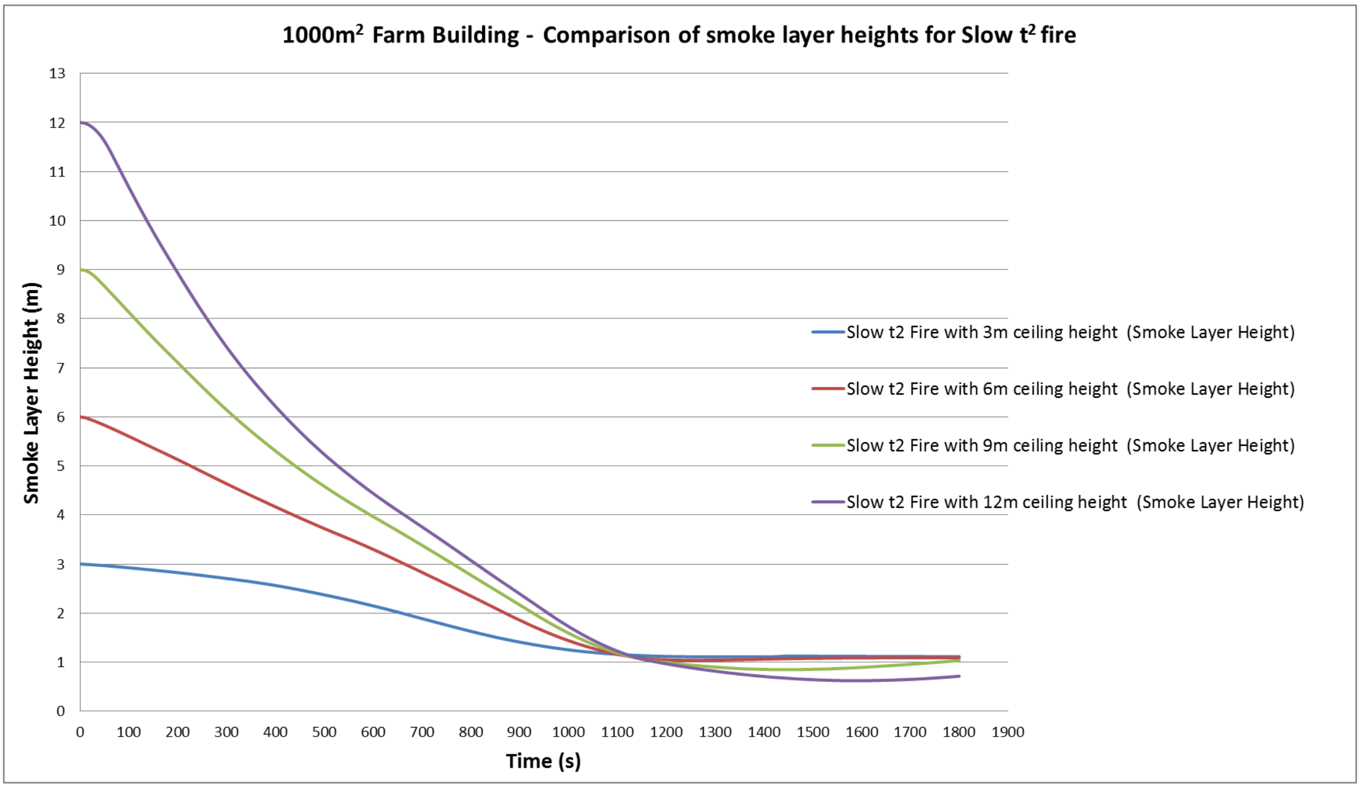


Figure 15: Smoke layer visibility for Slow t^2 fire within a floor area of $1000m^2$

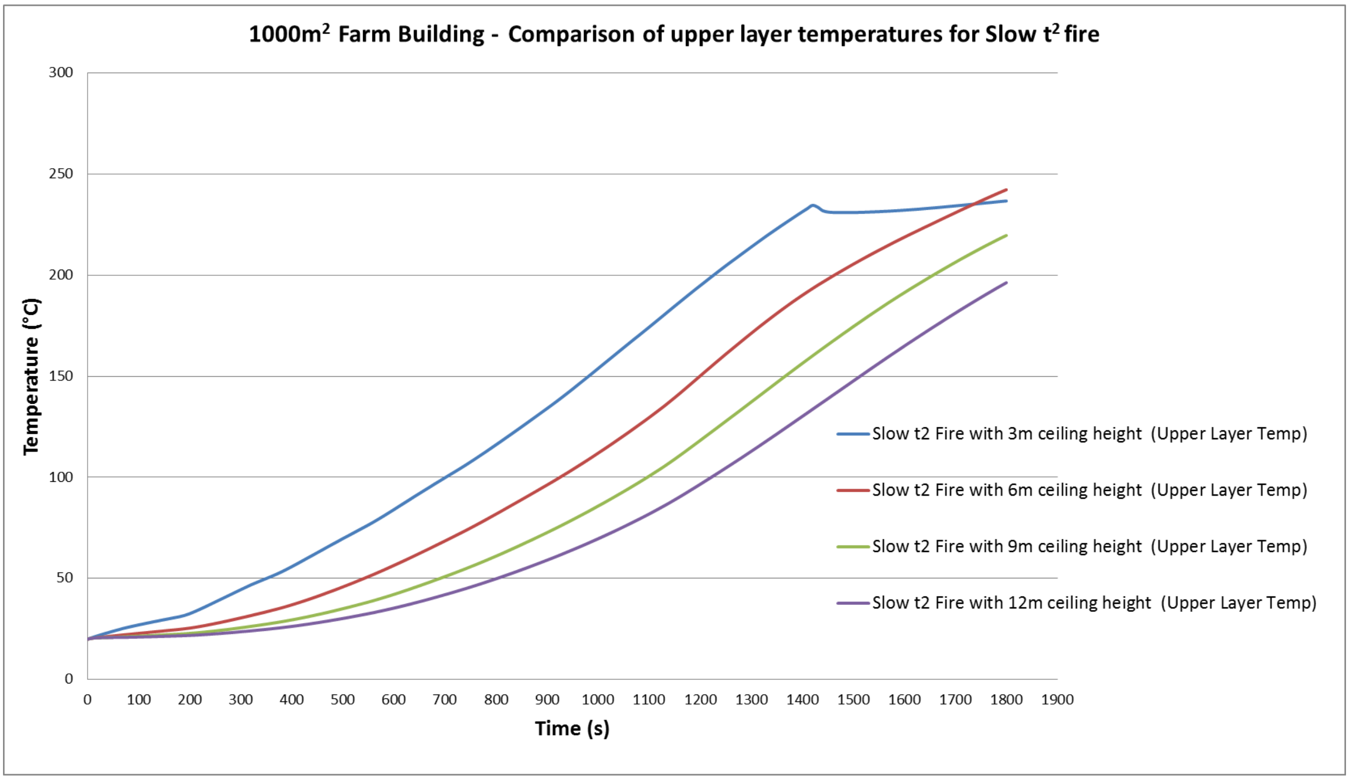


Figure 16: Smoke layer temperature for Slow t^2 fire within a floor area of $1000m^2$

Figure 17: Smoke layer visibility for <u>Slow t^2 fire</u> within an open walled building with floor area of 1000m²

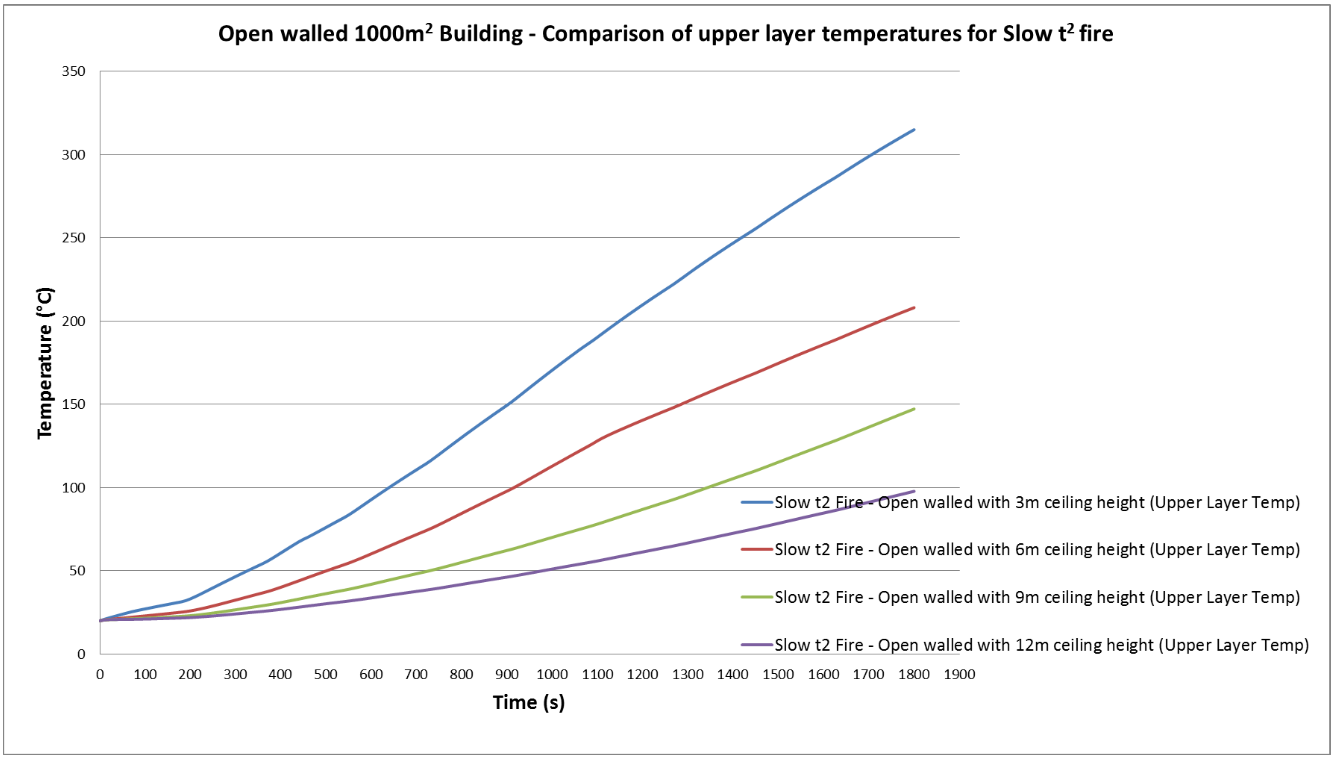


Figure 18: Smoke layer temperature for <u>Slow t^2 fire</u> within an open walled building with a floor area of 1000m²

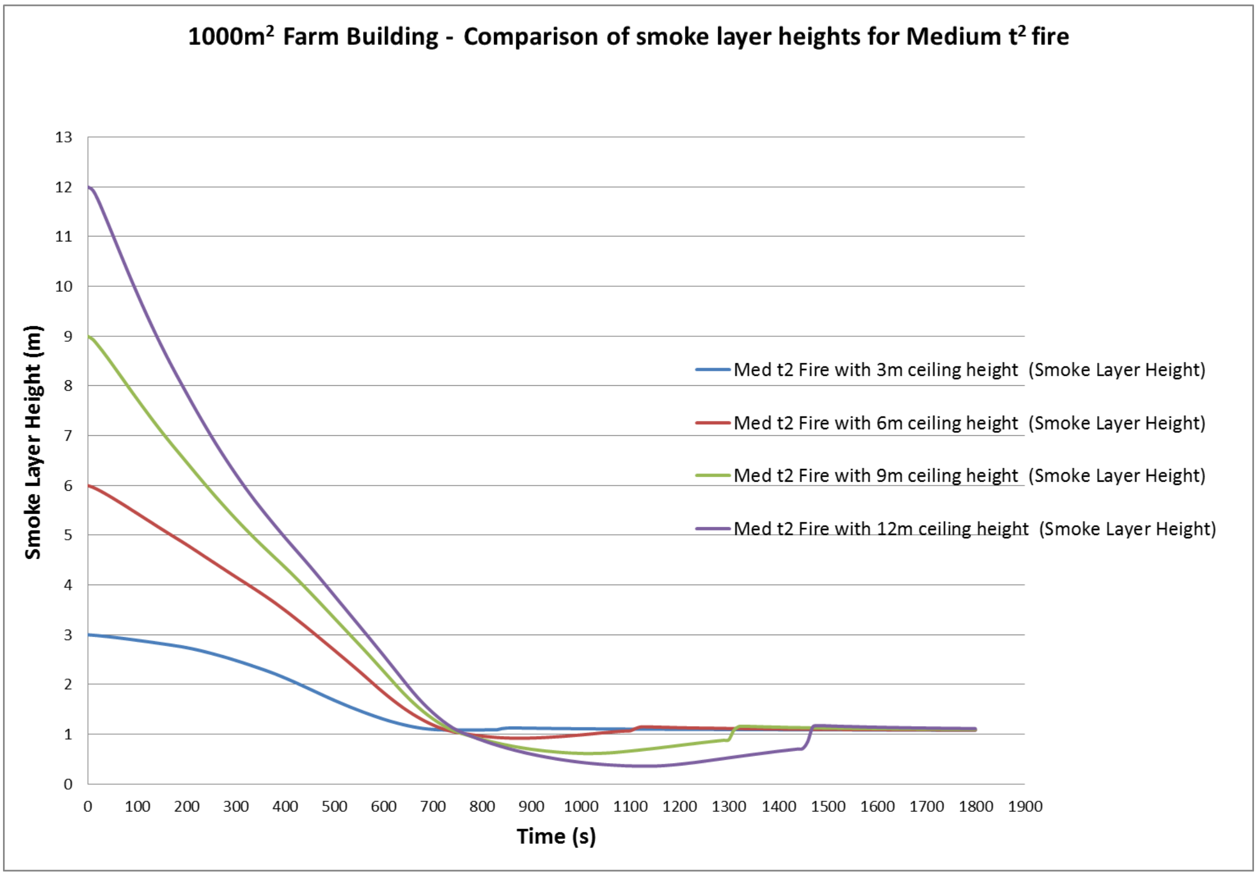


Figure 19: Smoke layer visibility for Medium t^2 fire within a floor area of 1000m²

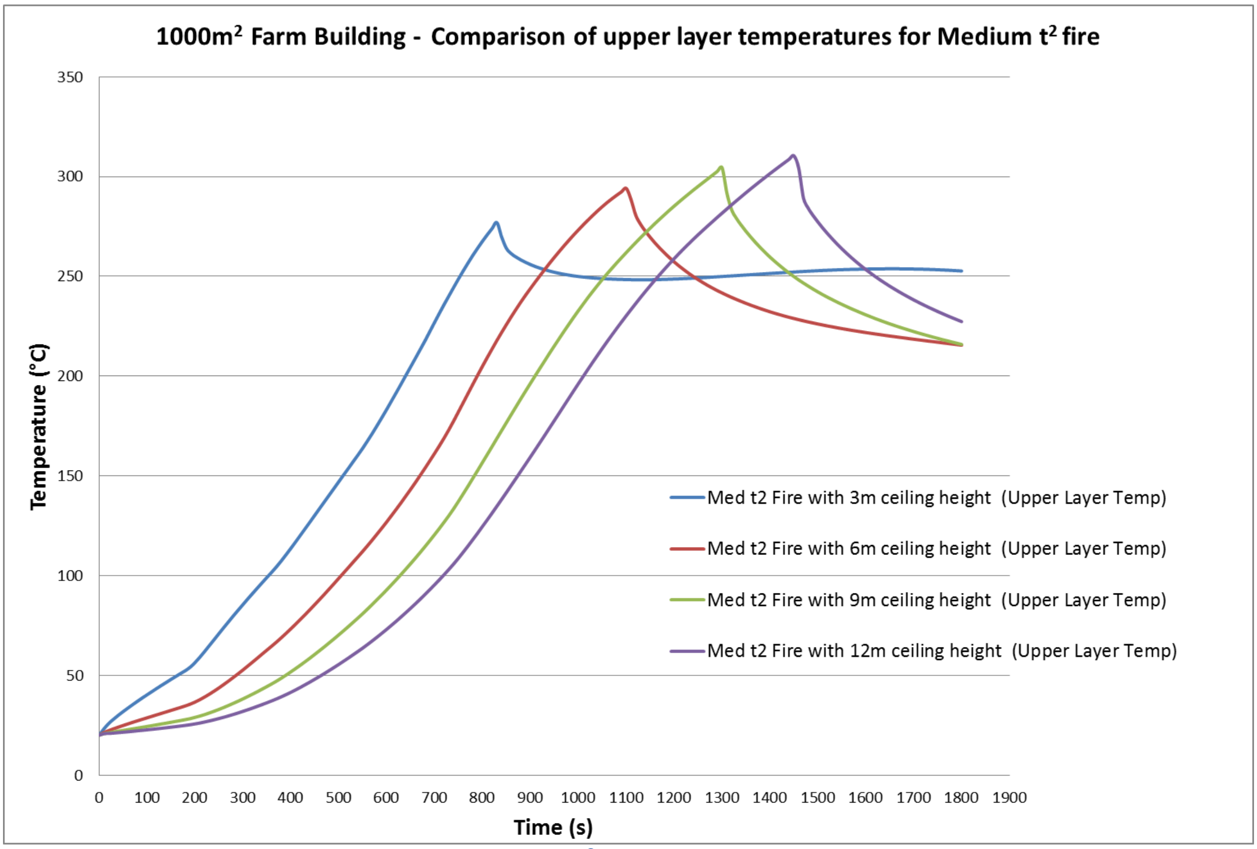


Figure 20: Smoke layer temperature for Medium t^2 fire within a floor area of 1000m²

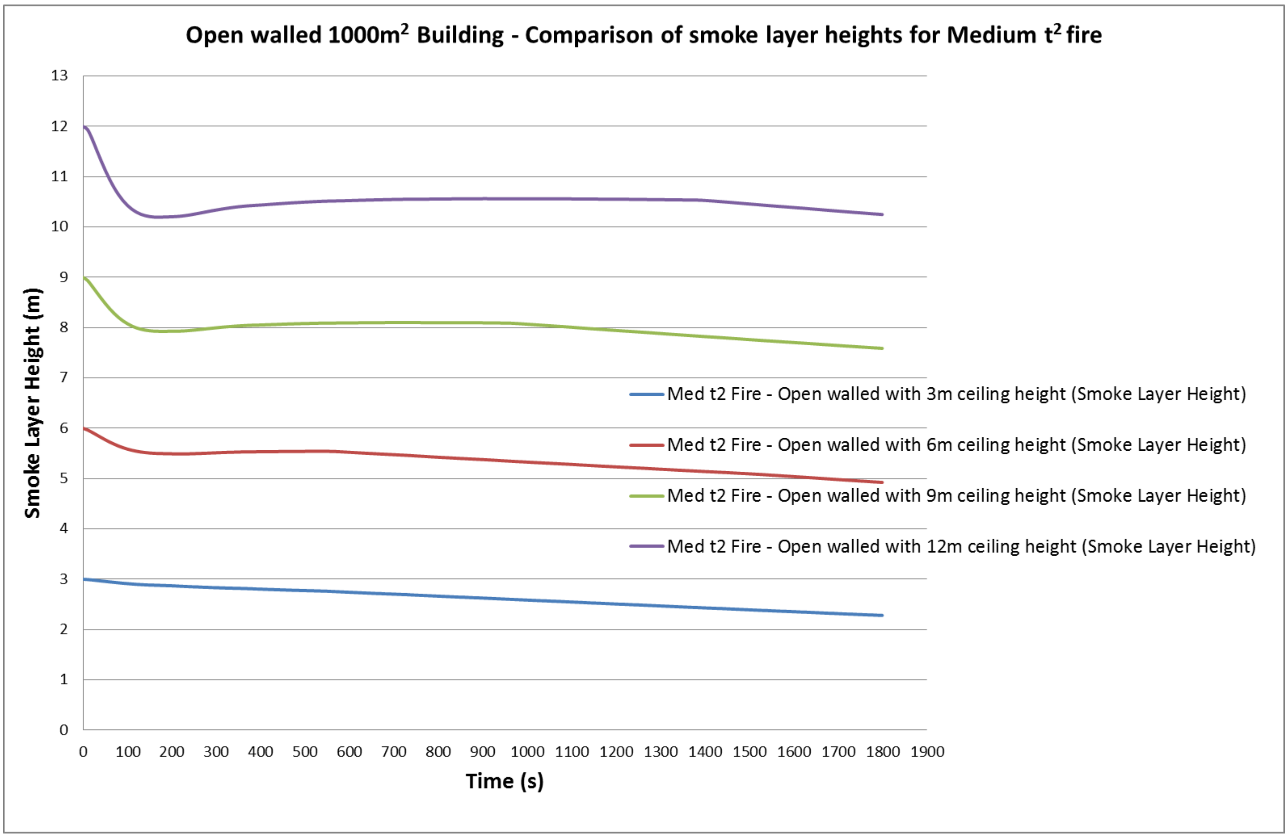


Figure 21: Smoke layer visibility for Medium t^2 fire within an open walled building with floor area of 1000m^2

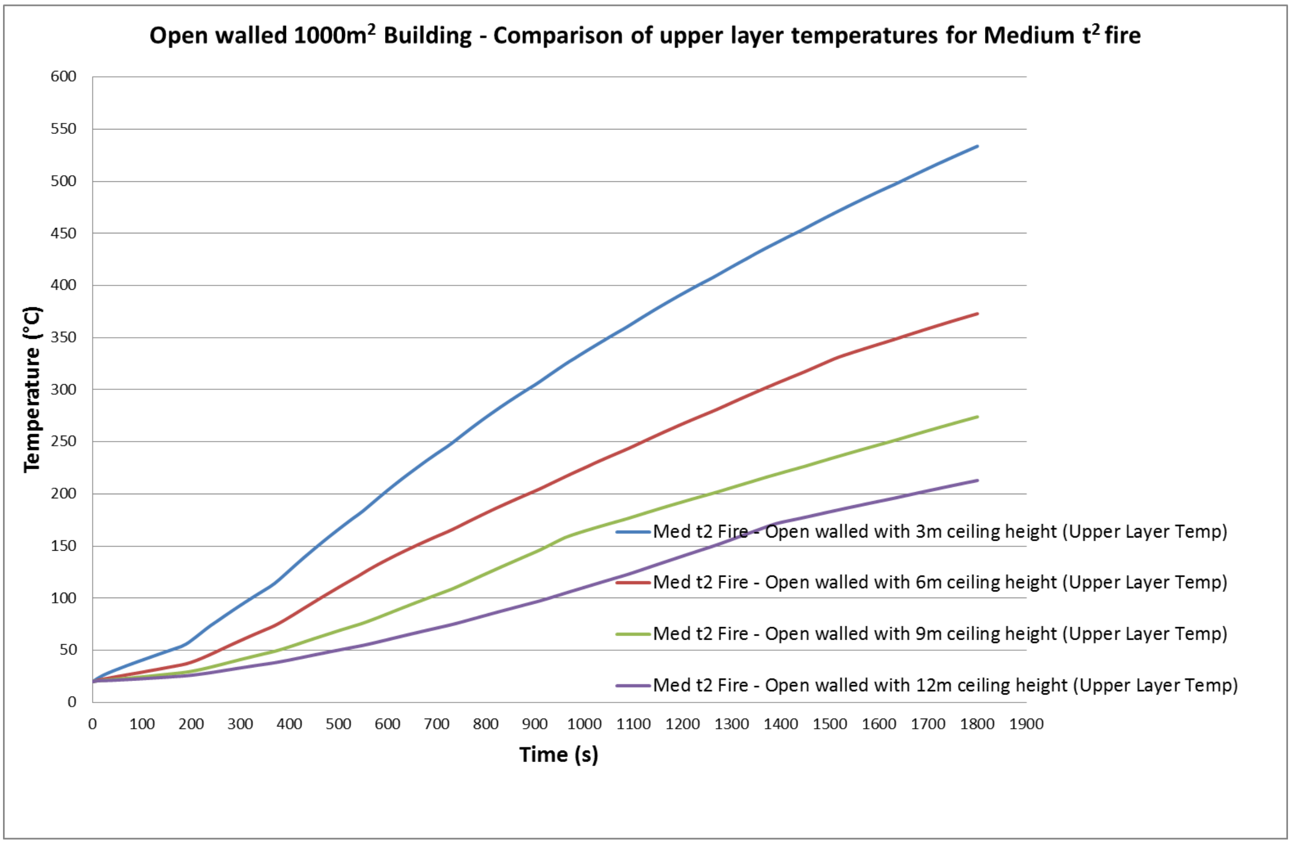


Figure 22: Smoke layer temperature for Medium t^2 fire within an open walled building with a floor area of 1000m^2

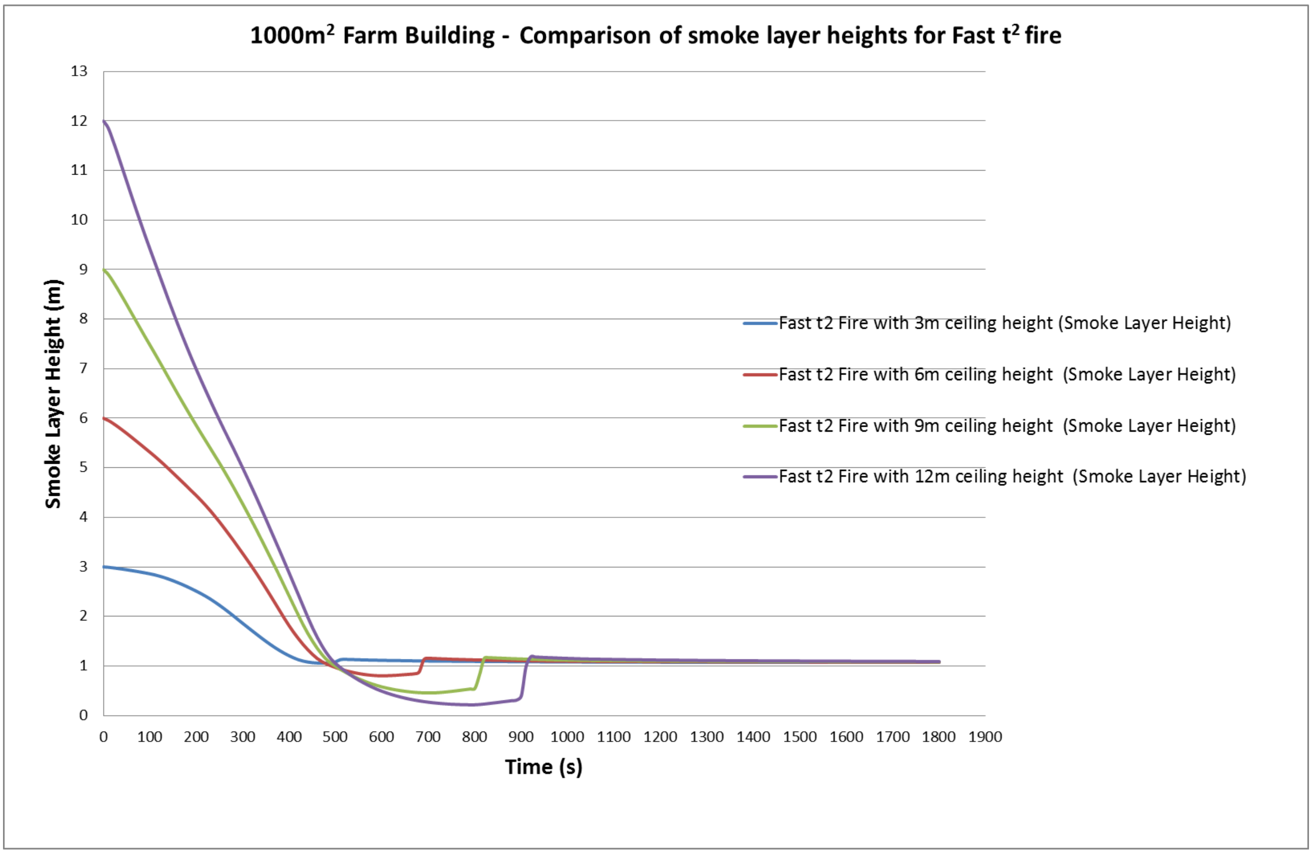


Figure 23: Smoke layer visibility for Fast t^2 fire within a floor area of 1000m²

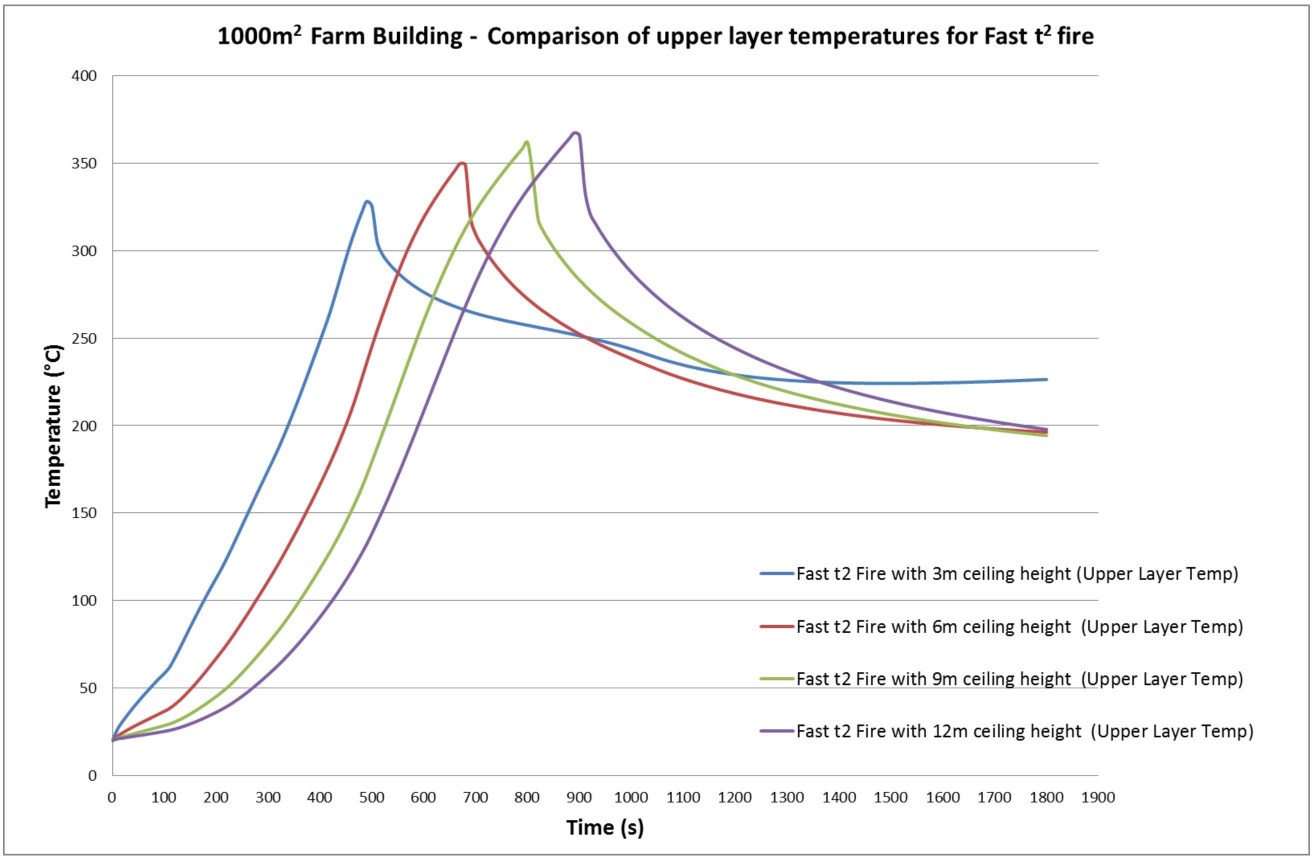


Figure 24: Smoke layer temperature for Fast t^2 fire within a floor area of 1000m²

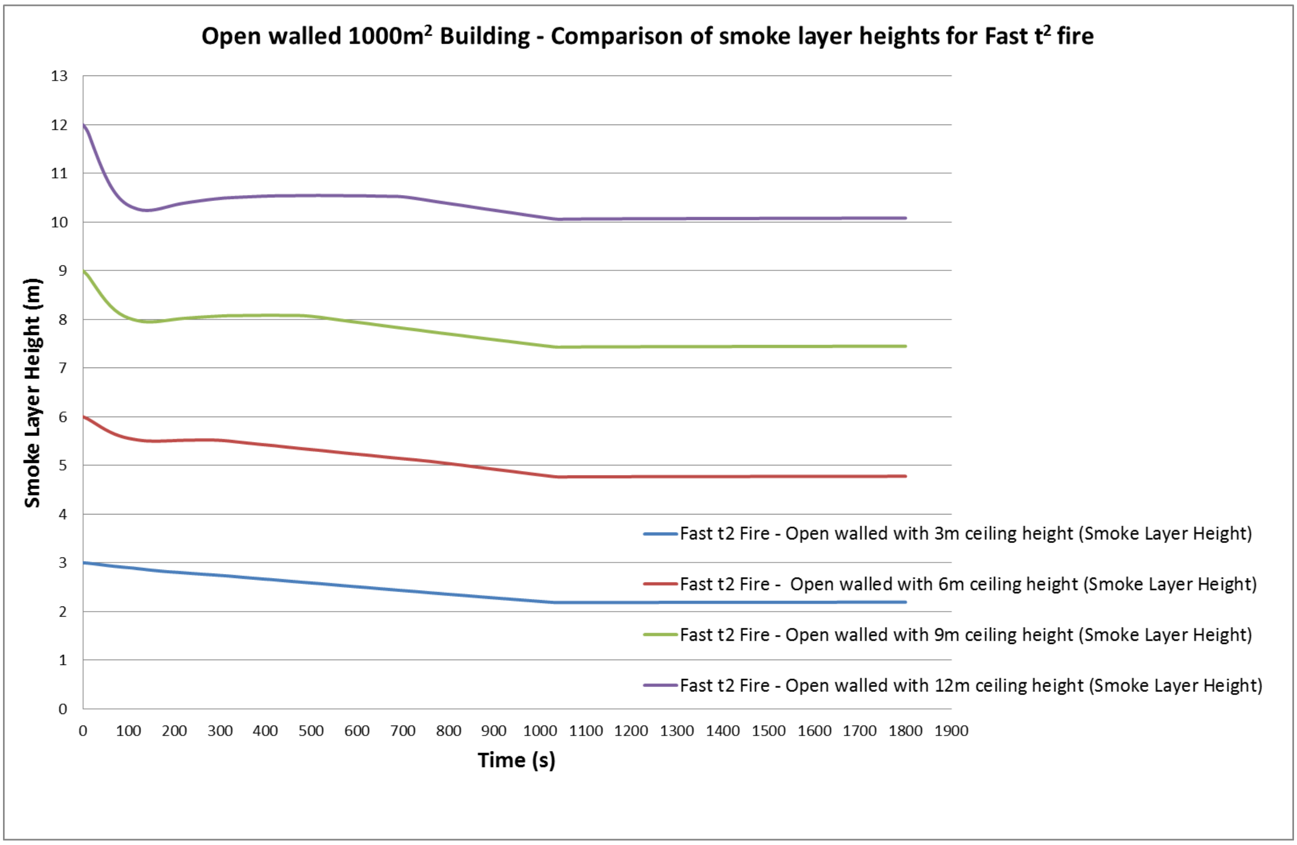


Figure 25: Smoke layer visibility for Fast t^2 fire within an open walled building with floor area of 1000m²

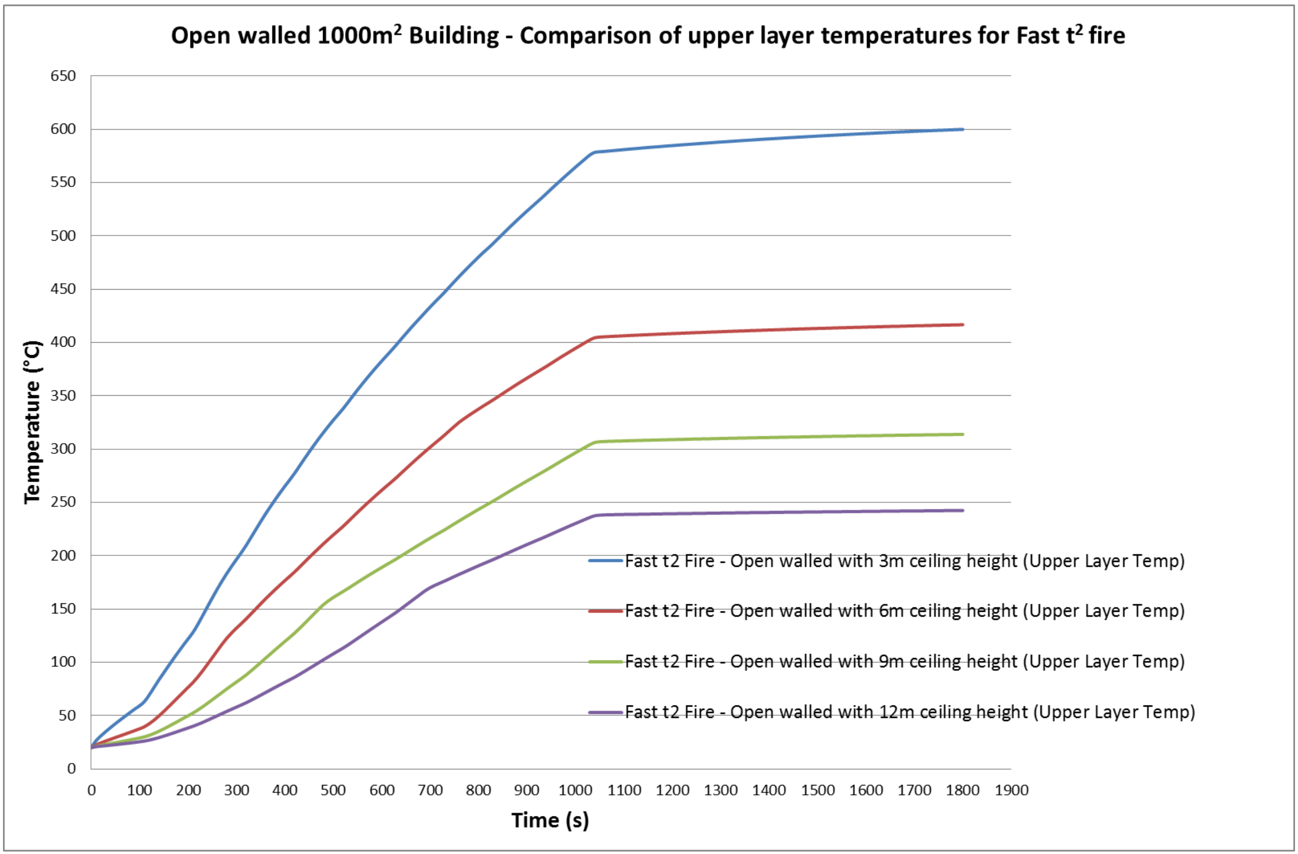


Figure 26: Smoke layer temperature for Fast t^2 fire within an open walled building with a floor area of 1000m²

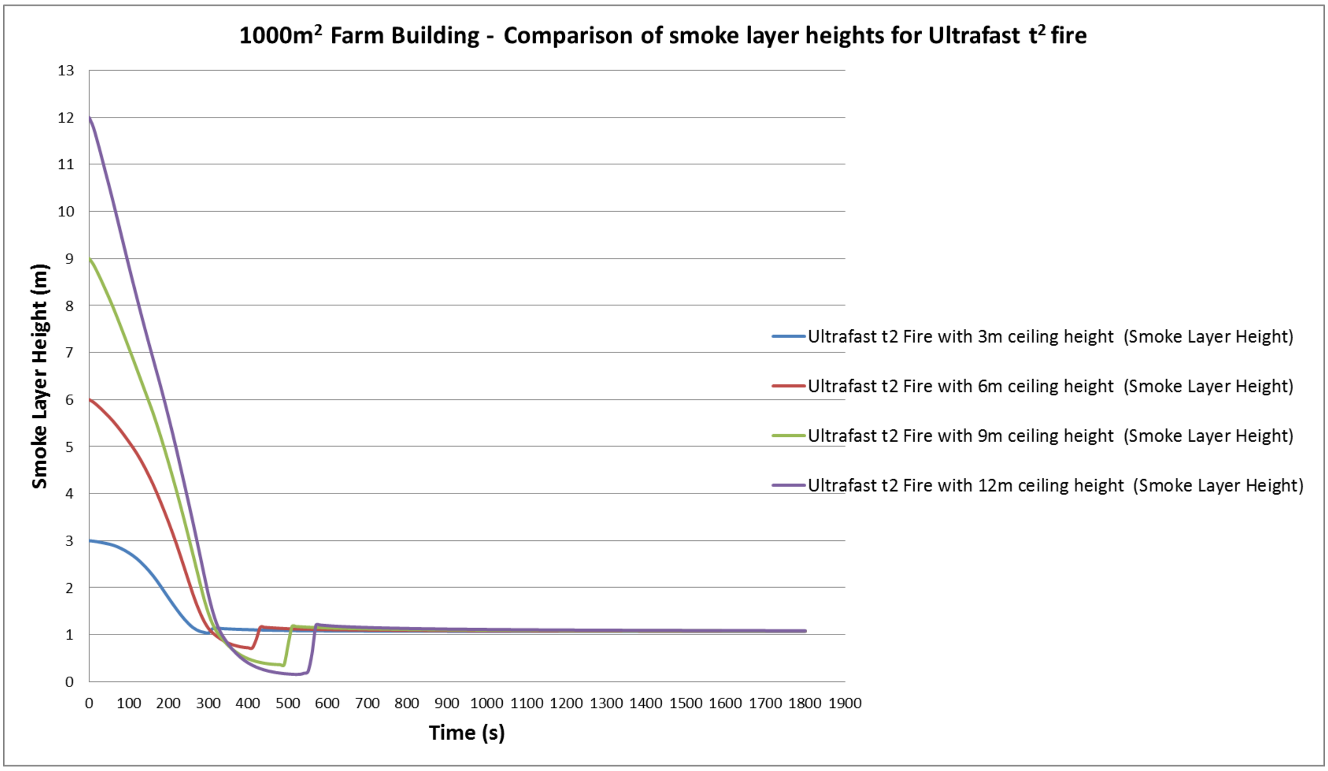


Figure 27: Smoke layer visibility for Ultrafast t^2 fire within a floor area of $1000m^2$

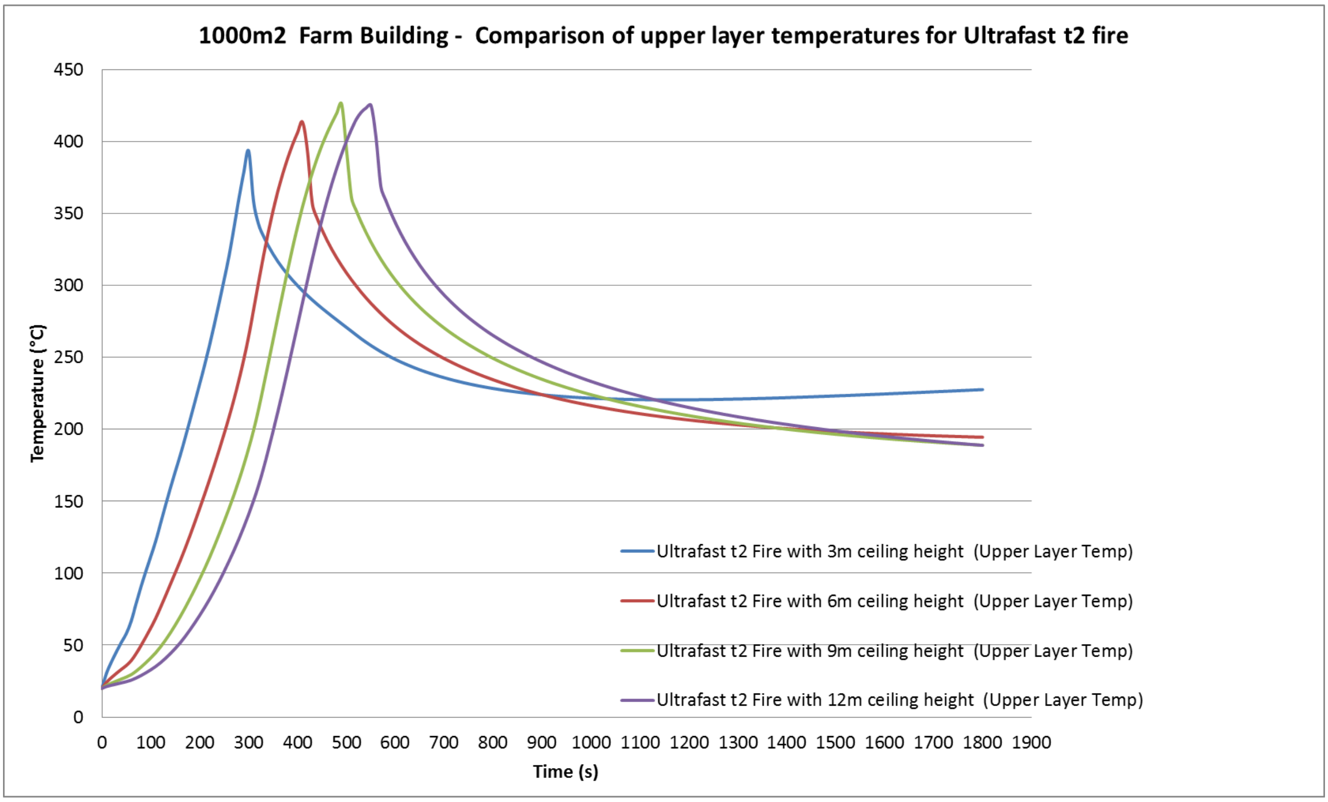


Figure 28: Smoke layer temperature for Ultrafast t^2 fire within a floor area of $1000m^2$

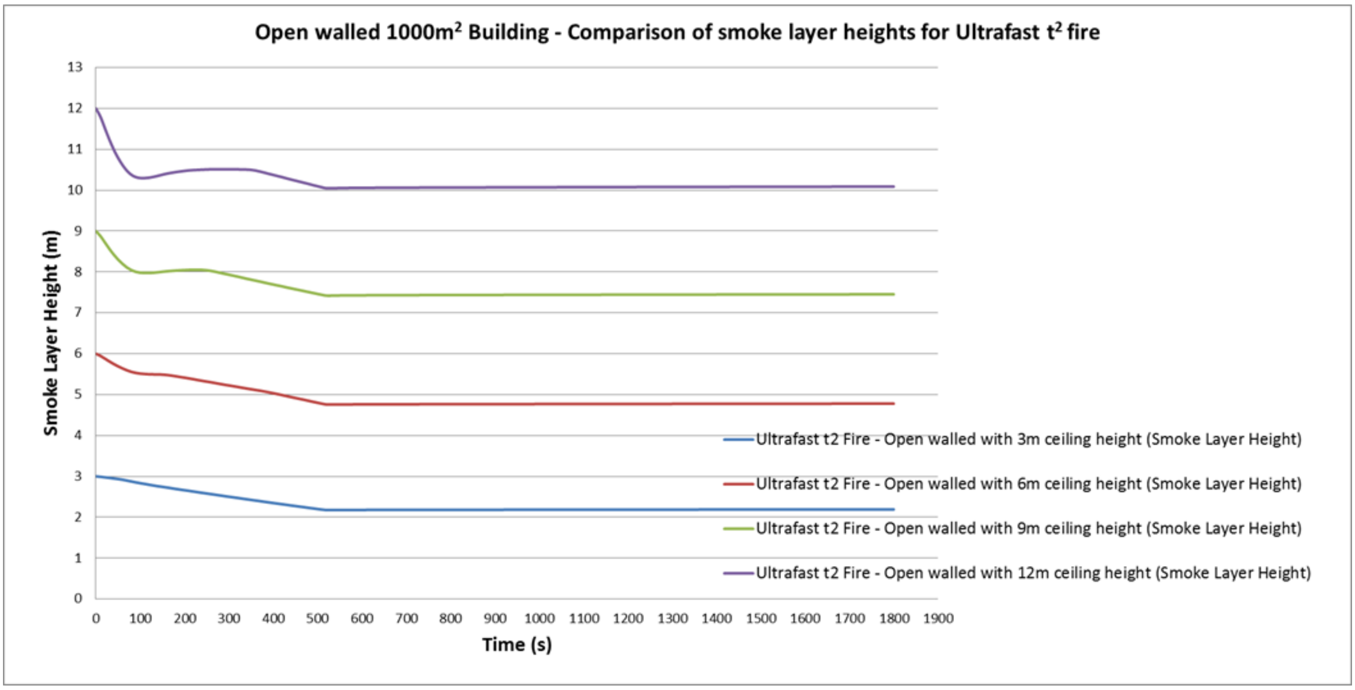


Figure 29: Smoke layer visibility for Ultrafast t^2 fire within an open walled building with floor area of 1000m²

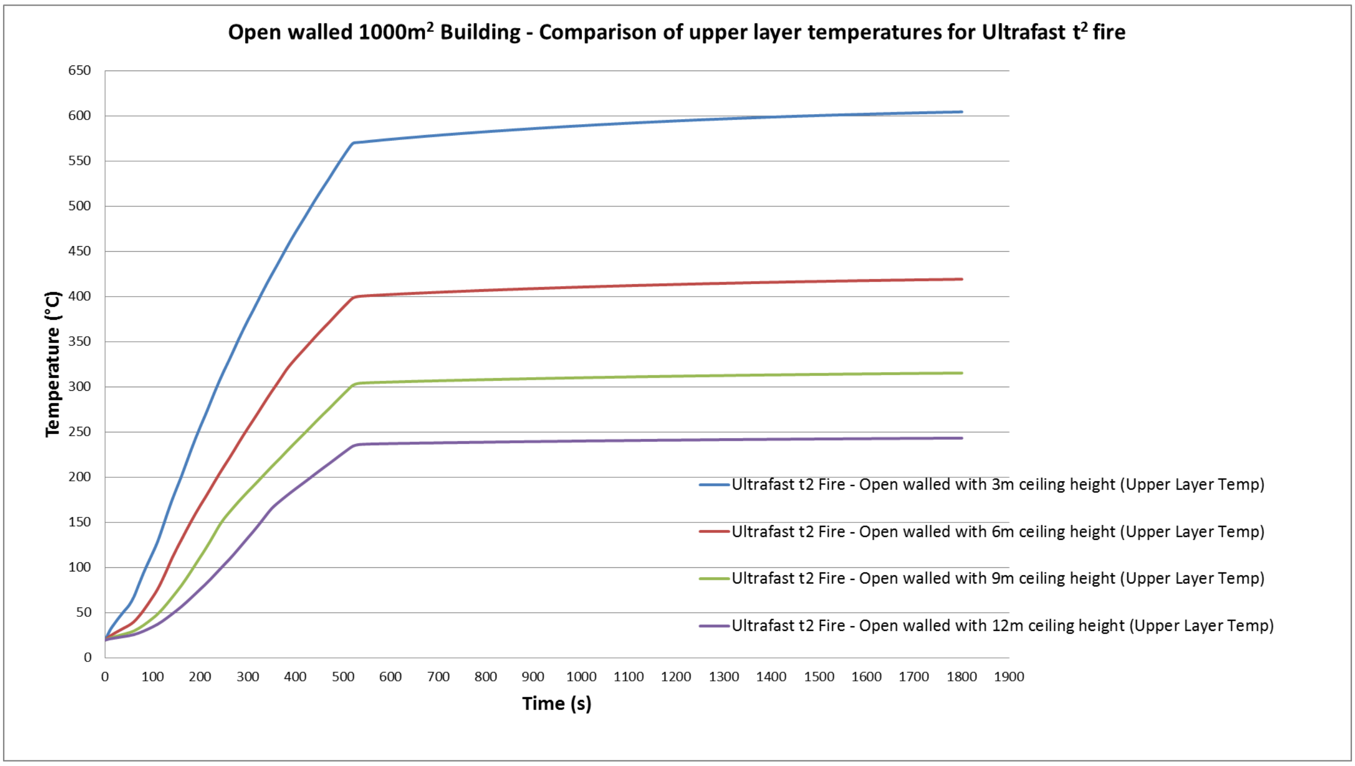


Figure 30: Smoke layer temperature for Ultrafast t^2 fire within an open walled building with floor area of 1000m²

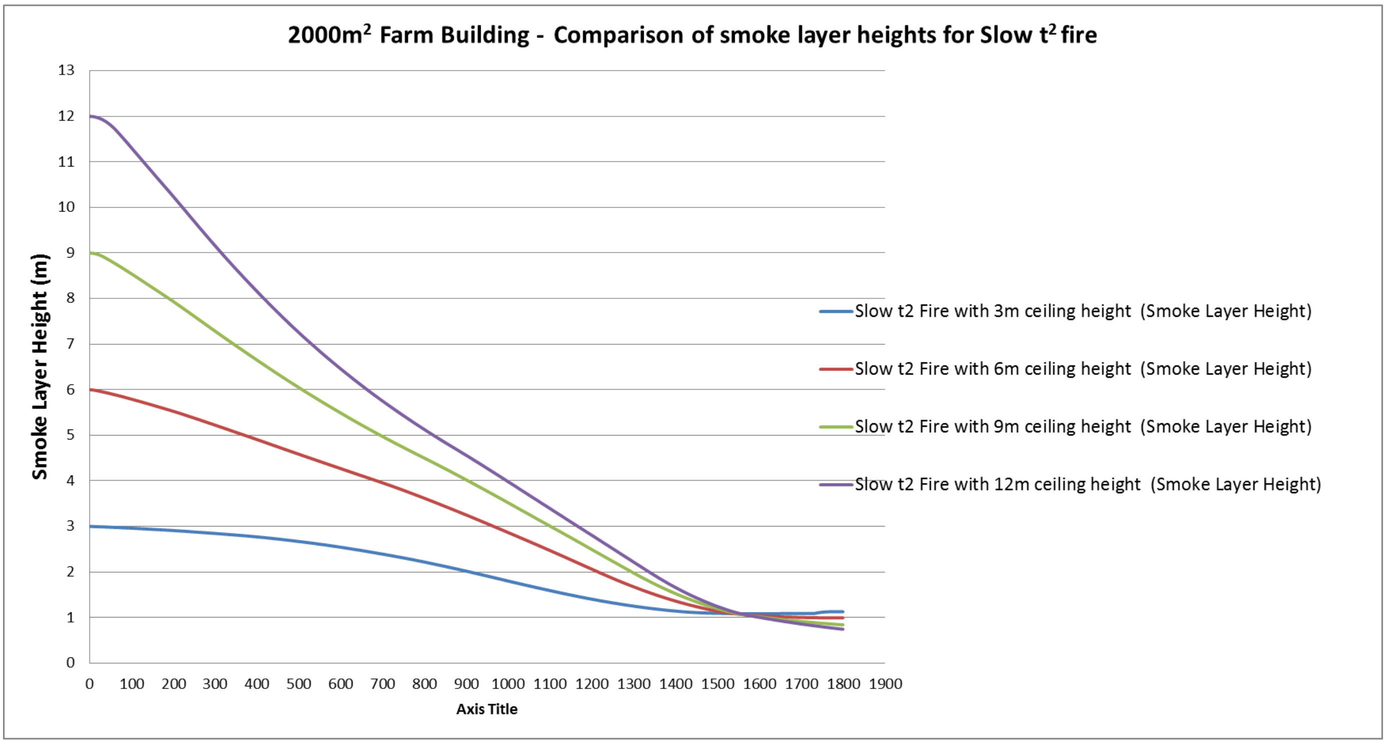


Figure 31: Smoke layer visibility for Slow t^2 fire within a floor area of $2000m^2$

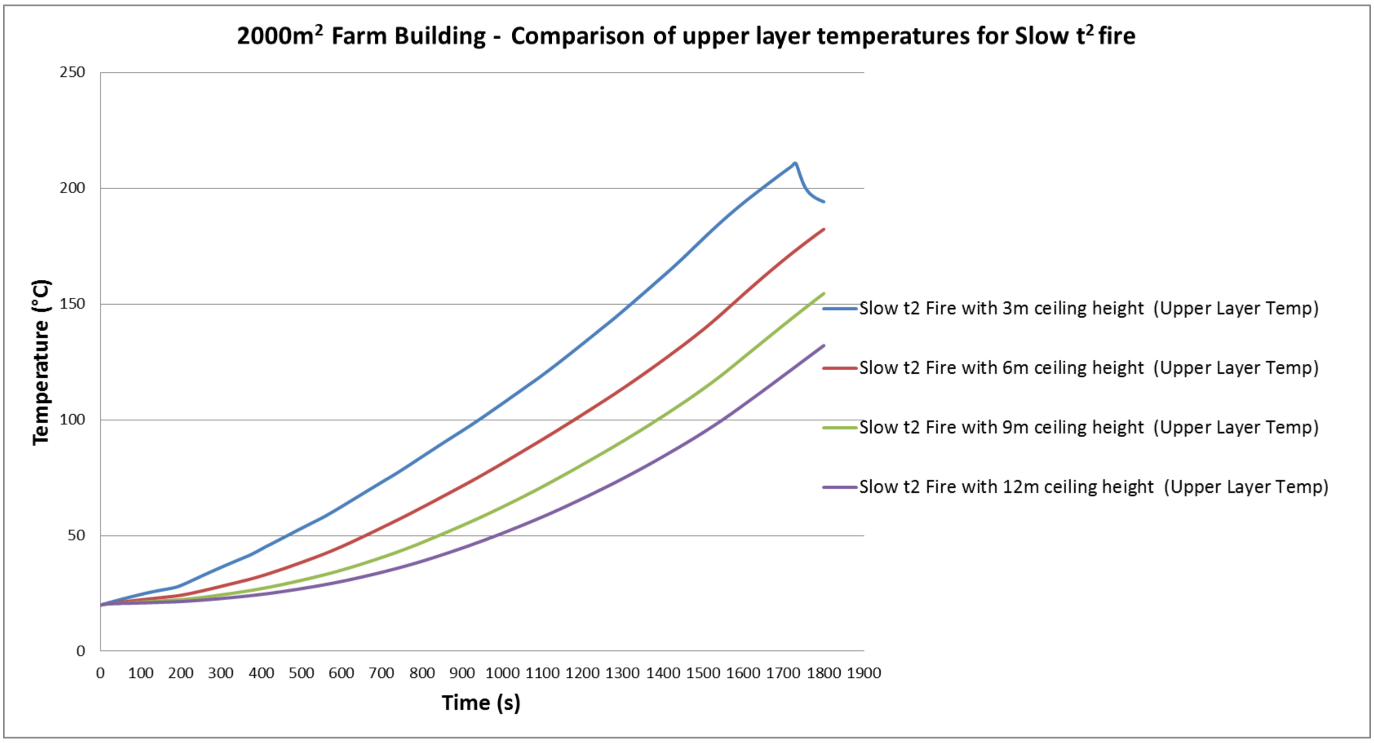


Figure 32: Smoke layer temperature for Slow t^2 fire within a floor area of $2000m^2$

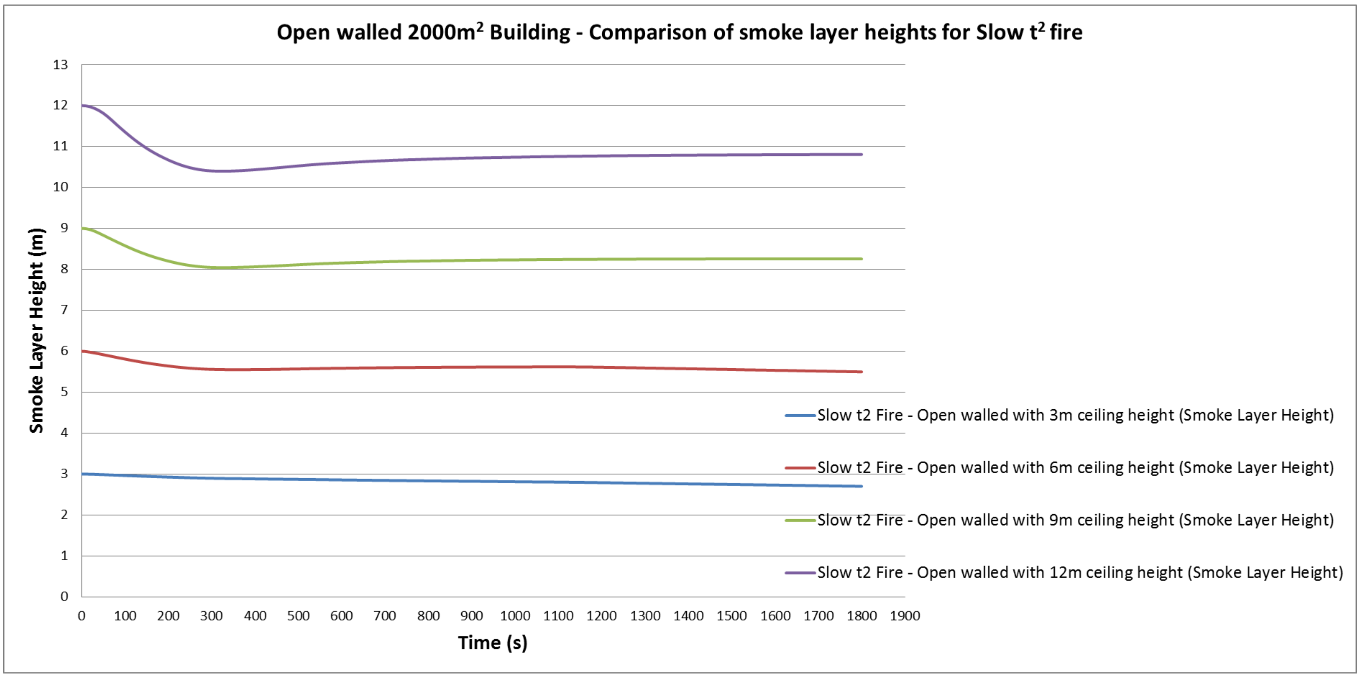


Figure 33: Smoke layer visibility for Slow t^2 fire within an open walled building with floor area of 2000m²

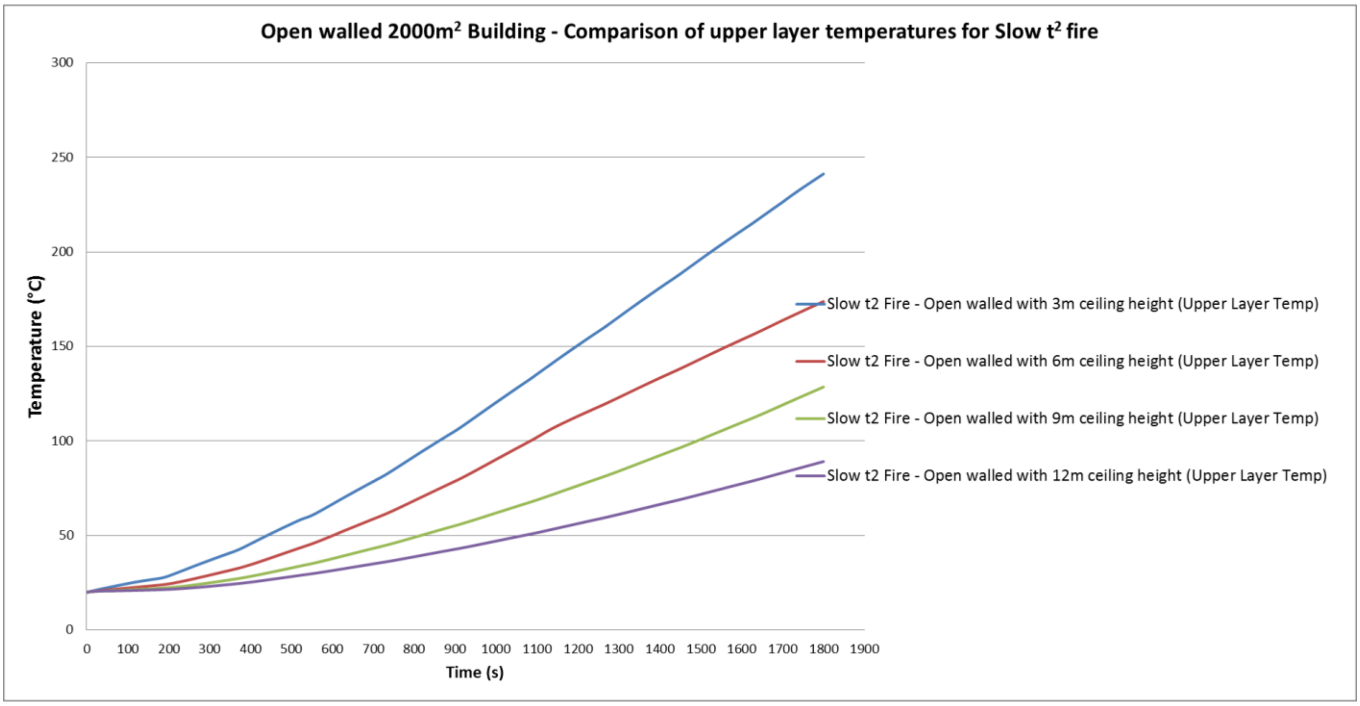


Figure 34: Smoke layer temperature for Slow t^2 fire within an open walled building with a floor area of 2000m²

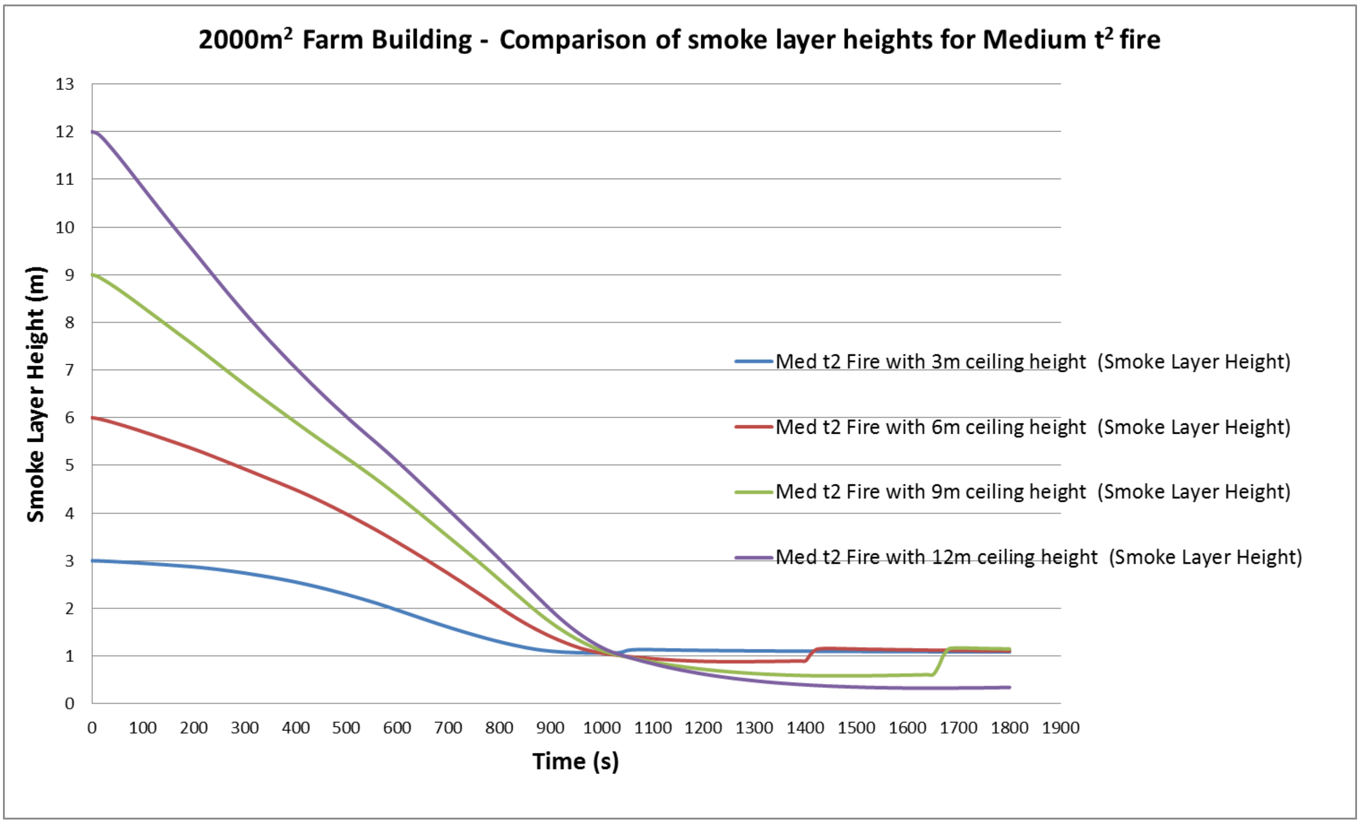


Figure 35: Smoke layer visibility for **Medium t^2 fire** within a floor area of $2000m^2$

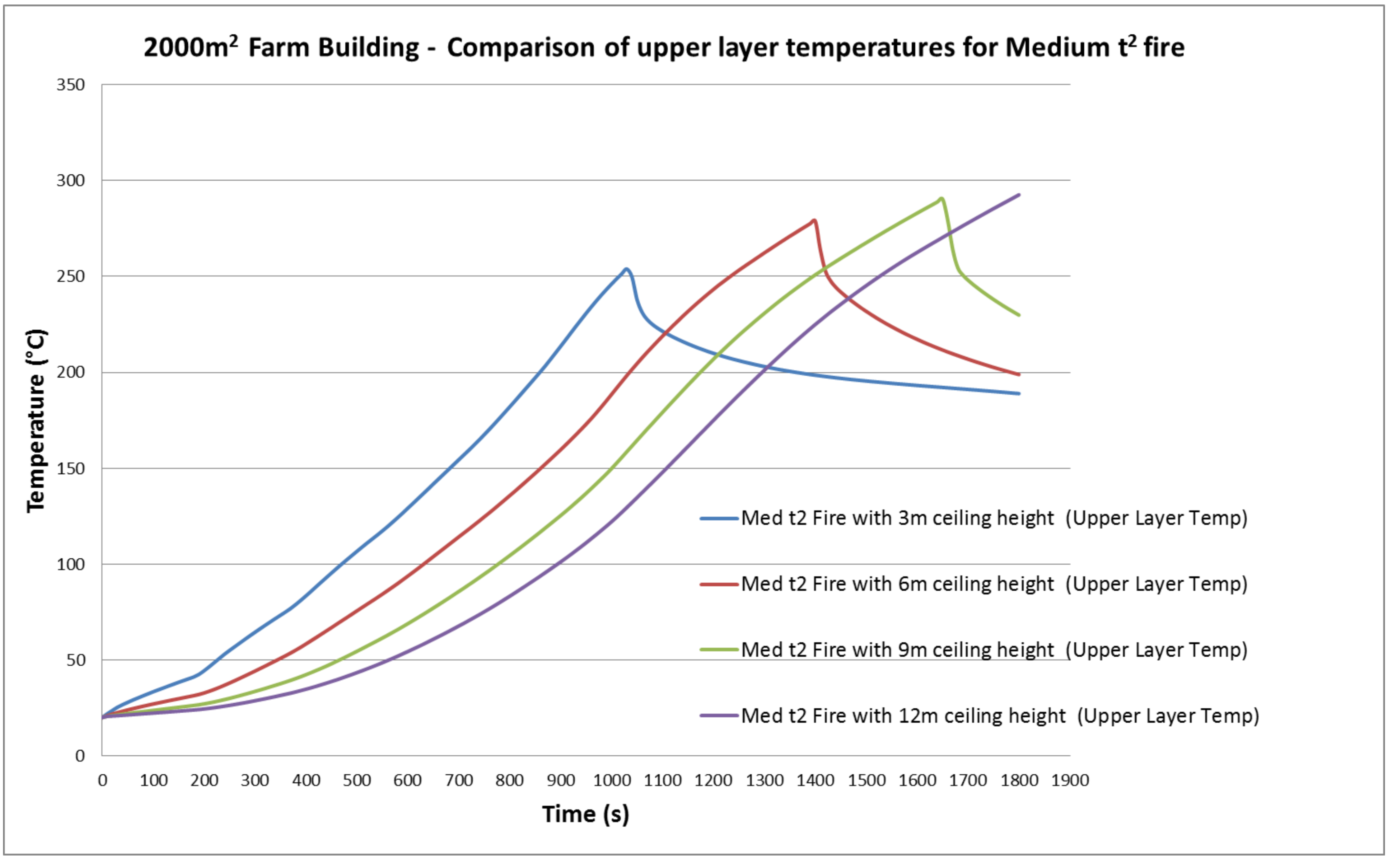


Figure 36: Smoke layer temperature for **Medium t^2 fire** within a floor area of $2000m^2$

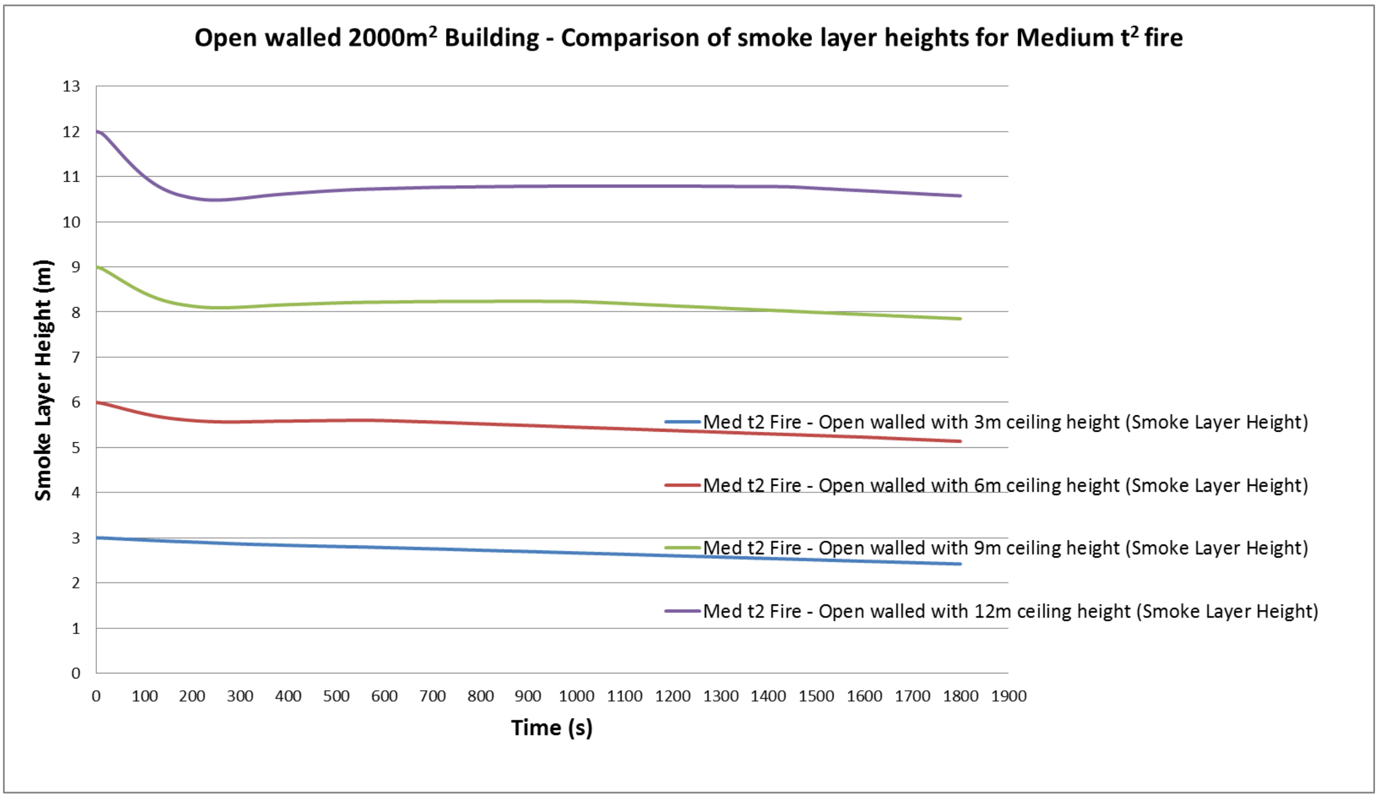


Figure 37: Smoke layer visibility for Medium t^2 fire within an open walled building with floor area of $2000m^2$

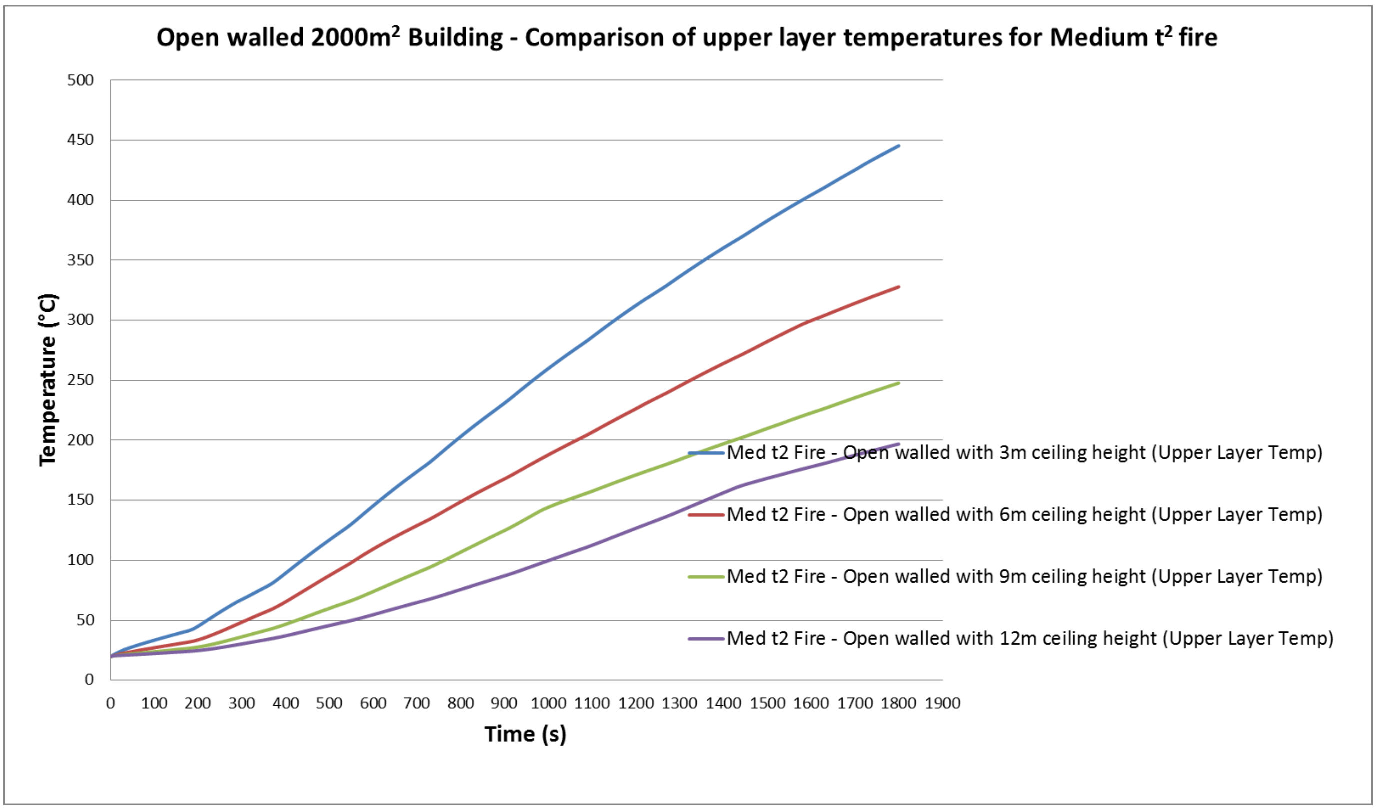


Figure 38: Smoke layer temperature for Medium t^2 fire within an open walled building with a floor area of $2000m^2$

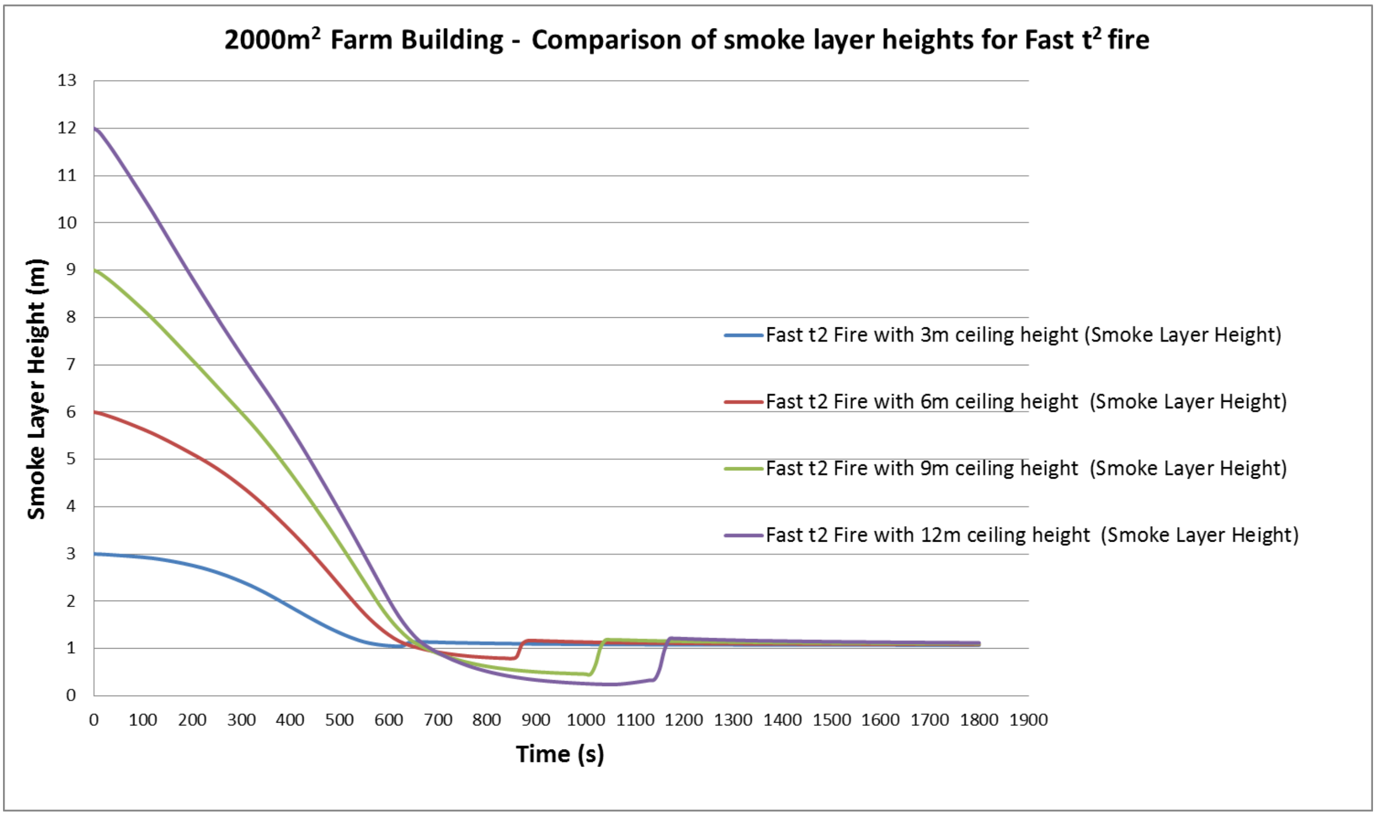


Figure 39: Smoke layer visibility for Fast t^2 fire within a floor area of $2000m^2$

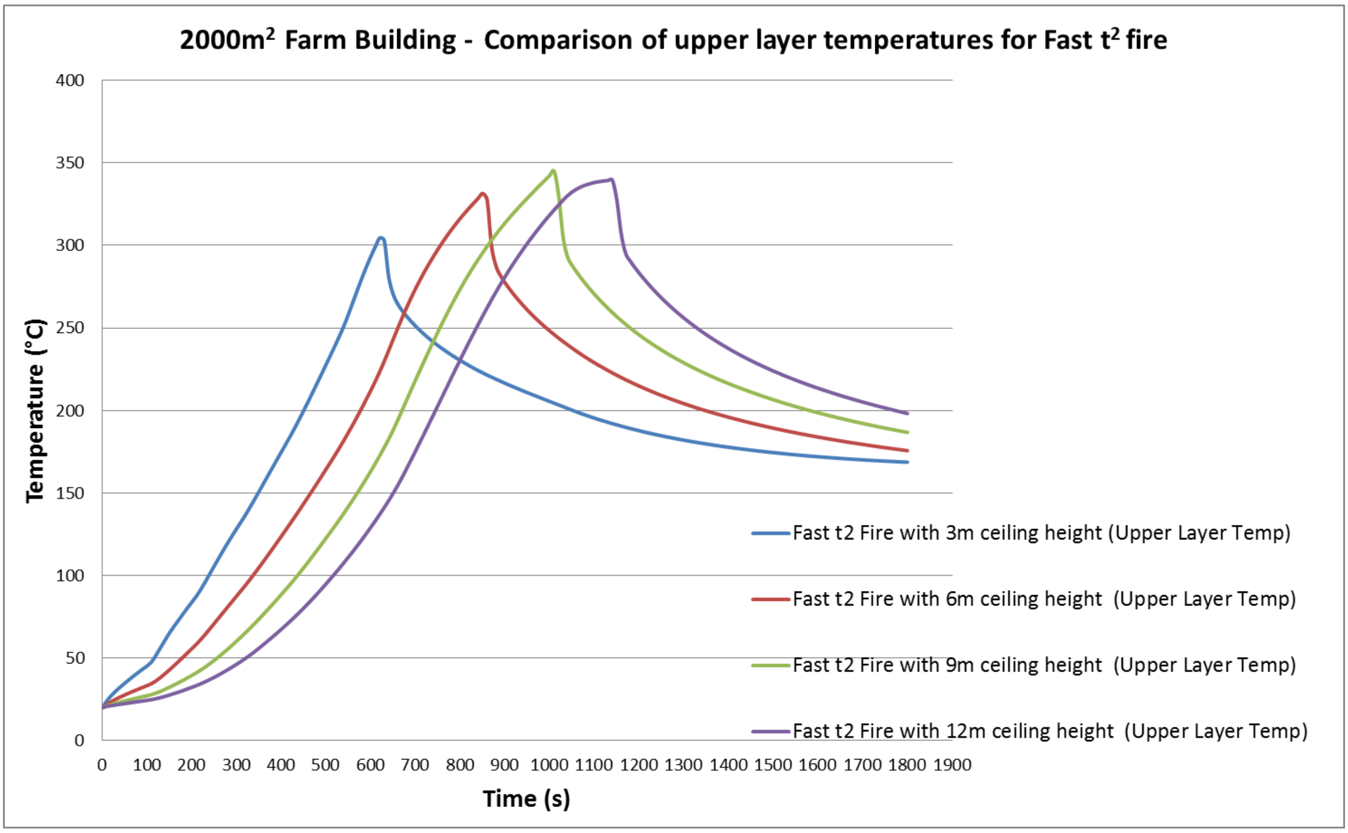


Figure 40: Smoke layer temperature for Fast t^2 fire within a floor area of $2000m^2$

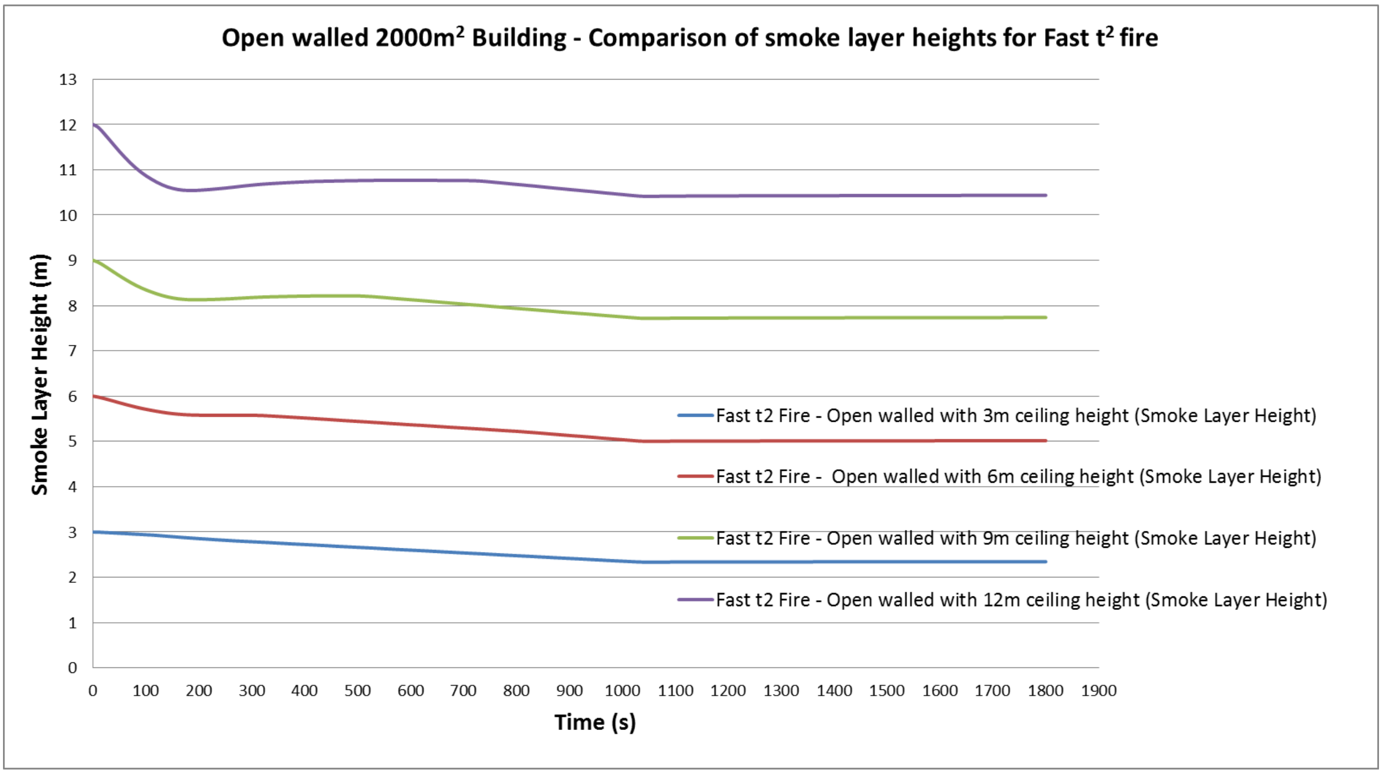


Figure 41: Smoke layer visibility for Fast t^2 fire within an open walled building with floor area of $2000m^2$

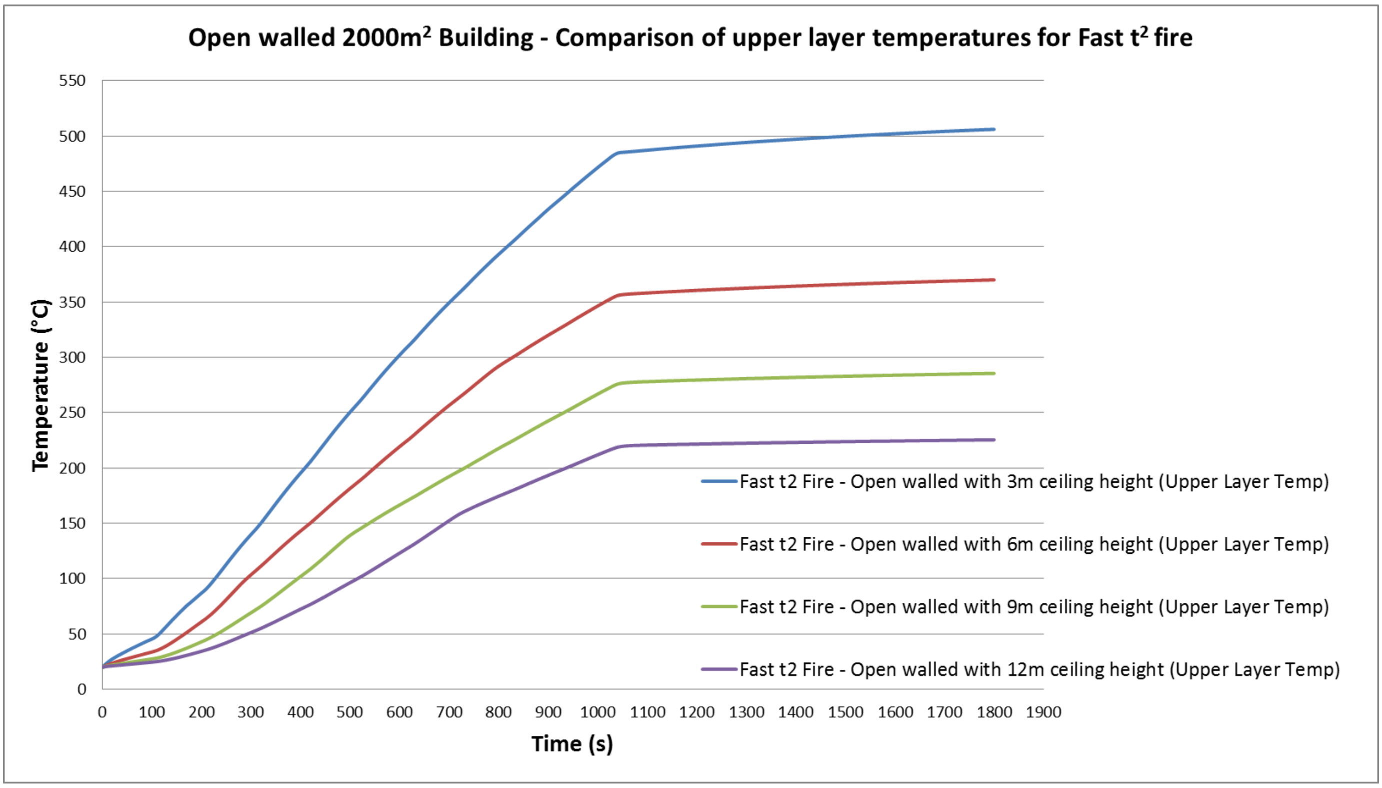


Figure 42: Smoke layer temperature for Fast t^2 fire within an open walled building with a floor area of $2000m^2$

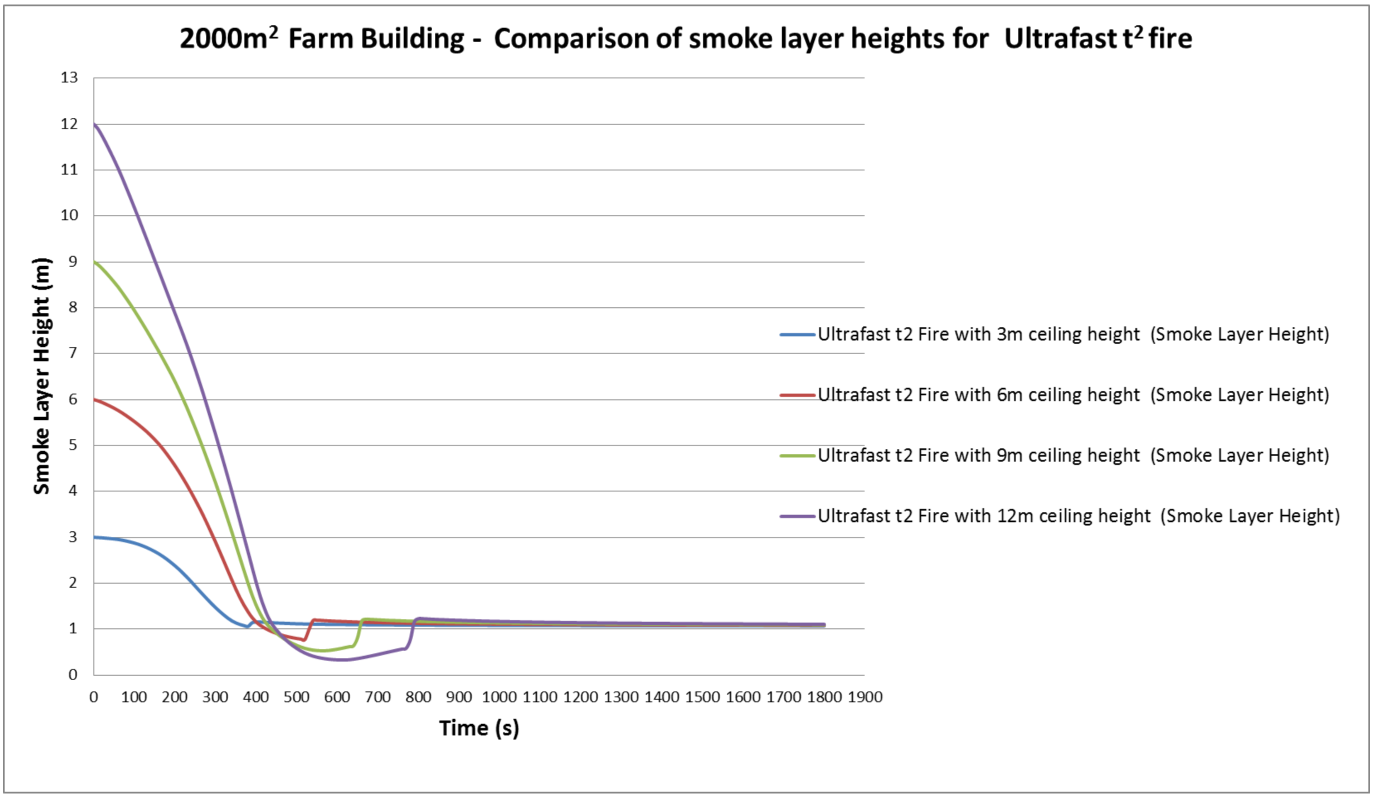


Figure 43: Smoke layer visibility for Ultrafast t^2 fire within a floor area of 2000m^2

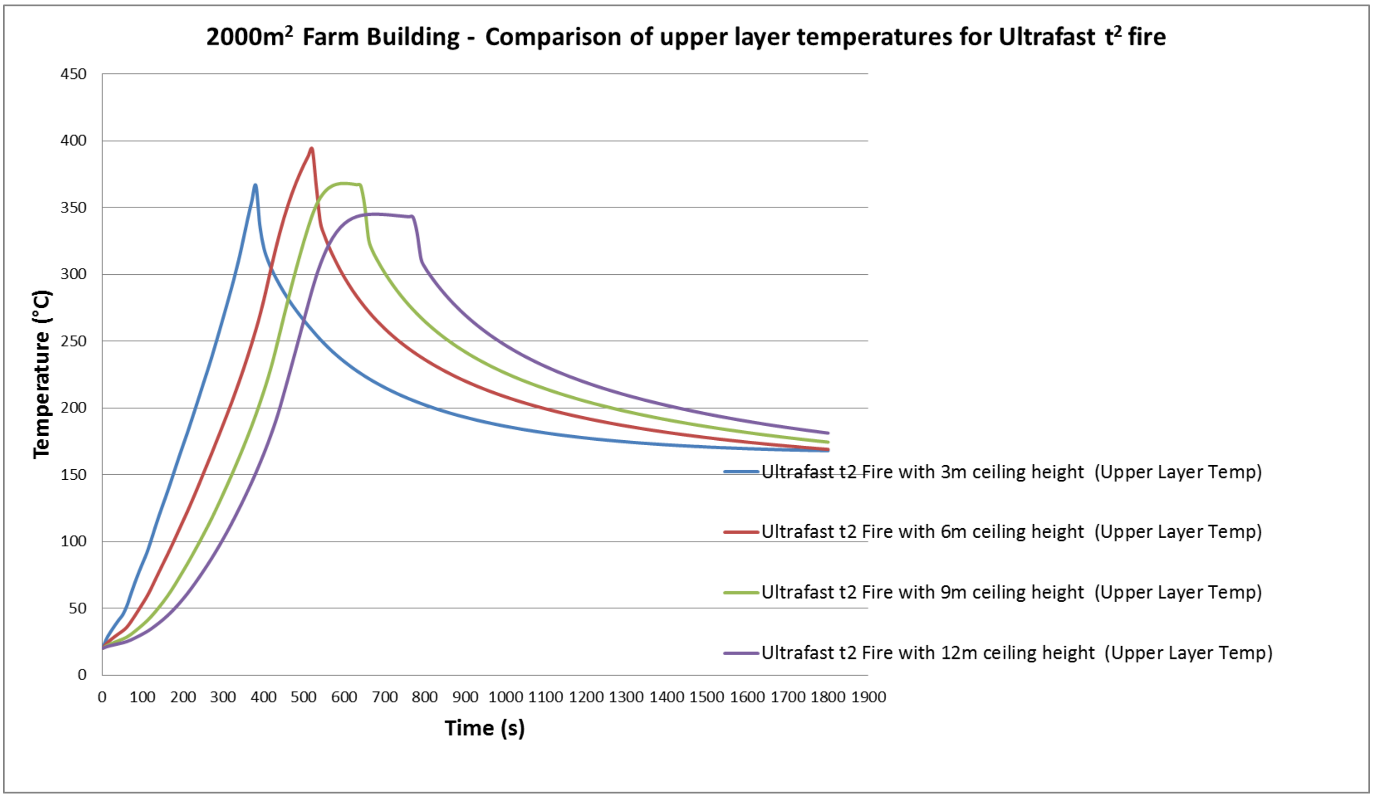


Figure 44: Smoke layer temperature for Ultrafast t^2 fire within a floor area of 2000m^2

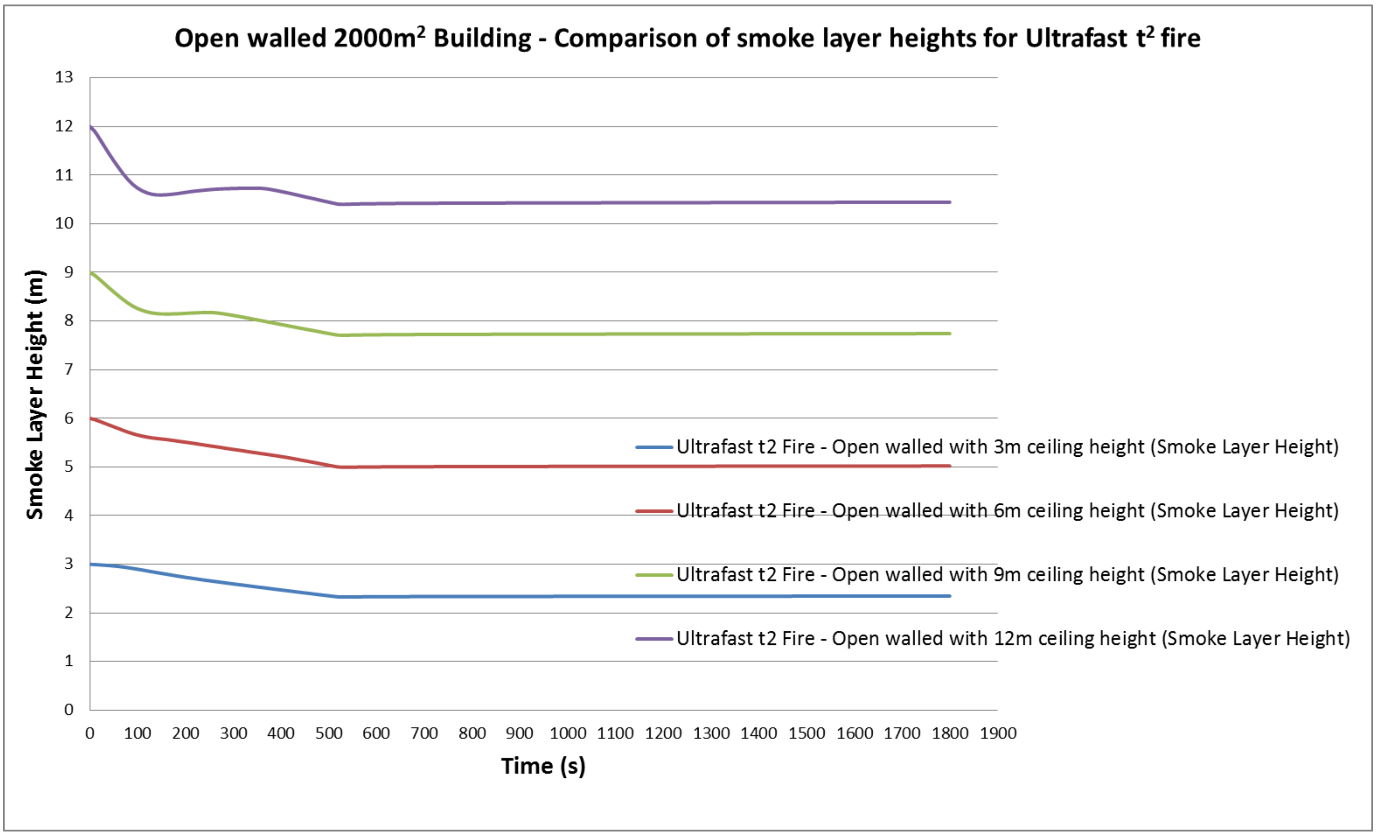


Figure 45: Smoke layer visibility for Ultrafast t^2 fire within an open walled building with floor area of 2000m²

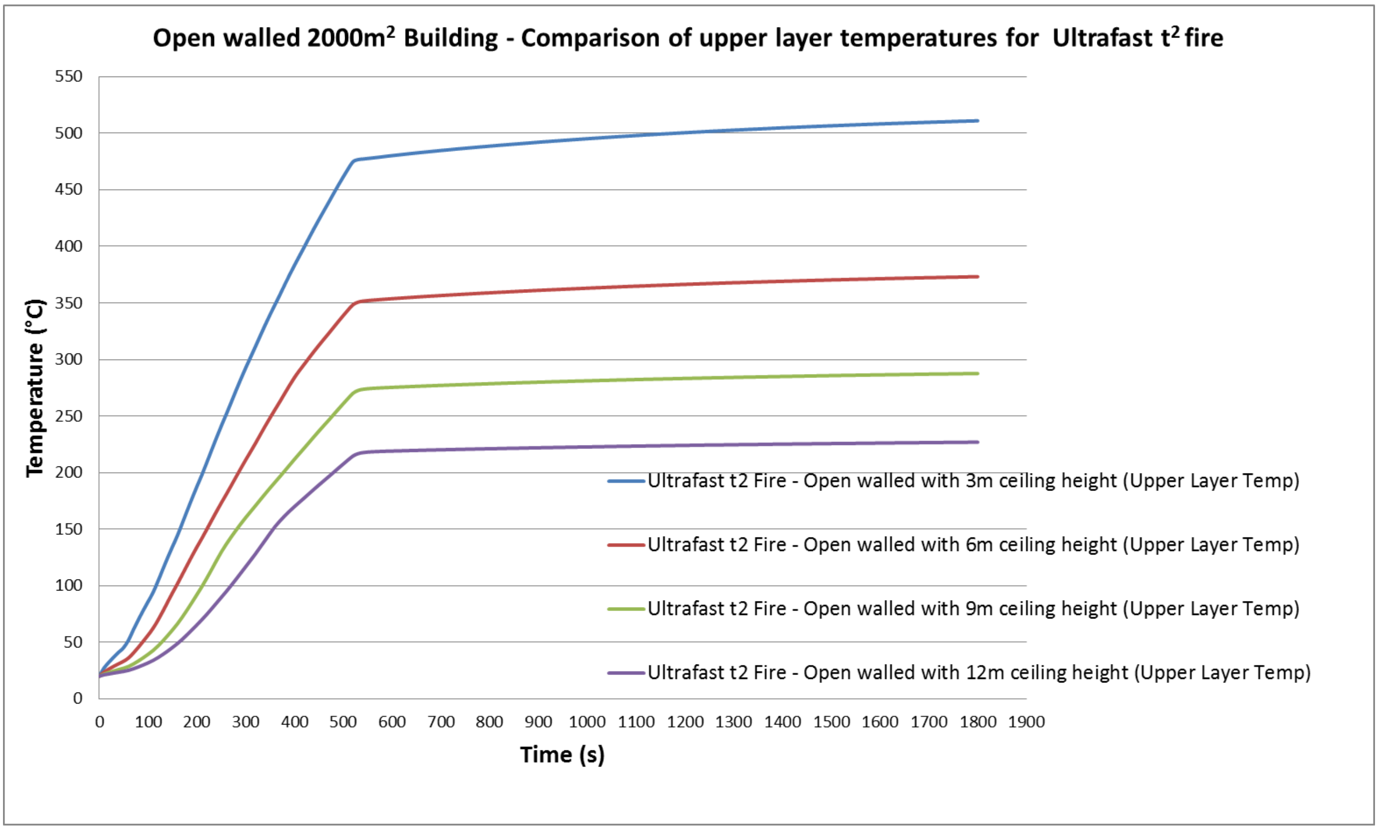


Figure 46: Smoke layer temperature for Ultrafast t^2 fire within an open walled building with floor area of 2000m²

6.4 Conclusion Based on QDC Part 3.7 Proposed 40m / 60m Travel Distances Applied

A review using simplistic CFAST analyses has been carried out to examine the smoke filling of smoke reservoirs. Considering the general expectancy of large smoke reservoirs in farm buildings. Theoretically tenable conditions are expected to be maintained for safe evacuation of occupants where fire growth is sufficiently slow or sufficiently high ceilings are present. The results are summarised below based on the outcomes obtained from **Section 7**.

It is concluded that an appropriate fire safety strategy needs to be adopted on a case-by-case basis to provide a building solution that would satisfy the performance requirements for fire and life safety provisions. The results suggest that the BCA objectives may not be fully achieved and satisfied for the requirements under smoke hazard management in QDC Part 3.7, unless a building design is strictly based on consideration for potential fire growth and ceiling heights adopted.

The results suggest that the proposed QDC Part 3.7 building solution with extended travel distance and distance between exits, would only satisfy the following buildings and fire growth scenarios with reference to the building areas analysed:

Table 17: Summary of Results – With Reference to Section 7 Below

Farm Building with Floor Area of 1000m^2 (60m Travel Distance x 2 Safety Factor)				
Fire Scenario	**Tenability FAIL**			
Ceiling Height	**3m**	**6m**	**9m**	**12m**
Slow t^2 Fire	-	-	-	-
Slow t^2 Fire - Open Walled	-	-	-	-
Medium t^2 Fire	-	-	-	-
Medium t^2 Fire - Open Walled	-	-	-	-
Fast t^2 Fire	-	-	-	-
Fast t^2 Fire - Open Walled	-	-	-	-
Ultra-Fast t^2 Fire	**FAIL**	-	-	-
Ultra-Fast t^2 Fire – Open Walled	**FAIL**	-	-	-
Farm Building with Floor Area of 2000m^2 (60m Travel Distance x 2 Safety Factor)				
Slow t^2 Fire	-	-	-	-
Slow t^2 Fire - Open Walled	-	-	-	-
Medium t^2 Fire	-	-	-	-
Medium t^2 Fire - Open Walled	-	-	-	-
Fast t^2 Fire	-	-	-	-
Fast t^2 Fire - Open Walled	-	-	-	-
Ultra-Fast t^2 Fire	**FAIL**	-	-	-
Ultra-Fast t^2 Fire – Open Walled	**FAIL**	-	-	-

Considering that for many farm building usages fast to ultra-fast fire growth scenarios are plausible, the findings of this review conclude that the smoke hazard management requirement P2 in QDC Part 3.7 is only deemed acceptable for building heights which exceed an average ceiling height in the order of 3m.

It is further concluded that application of the 20m / 40m BCA deemed to satisfy travel distances should be considered in lieu of current 40m / 60m proposal in QDC Part 3.7, to cater for uncertainties and variables in building occupancy types and different usages.

Conservatism applied in the assessment with proposed 40m / 60m travel distance with 2 x safety factor warrants consideration when strictly compared to methodology and acceptable solutions currently applied in the BCA deemed to satisfy 20m / 40m provisions, where safety factors are not part of the standard design consideration. Reference should be made to CFAST methodology in Section 6.2.5 which discusses the limitations associated with zone modelling used for assessments.

7 A3 Access and Egress

7.1 Purpose

The purpose of access and egress in buildings is to provide a reasonable degree of safety to the occupants and to provide a degree of protection for fire fighters in the event they must perform firefighting or rescue operations in a building.

Integral to the above is the means of egress necessary for occupants to escape or avoid a fire. Means of egress may be considered the lifeline of a building during an emergency event that will:

- give occupants alternative paths of travel to a place of safety to avoid a fire
- shelter occupants from fire and the products of combustion
- accommodate all occupants of a structure
- have clear, unobstructed, well-marked and illuminated egress

The intent of the BCA is to maximise the safety of occupants by enabling them to be close enough to an exit to safely evacuate. Travel distances are based on an assumption of what is considered "reasonable" distances to be travelled by occupants in reaching an exit.

7.2 Legislation Comparison

Comparison of current legislations presented for access and egress for farm buildings are as detailed in Table 18 below:

Table 18: Legislation comparison for Access and Egress

Name of code/legislation	Access and Egress
International Building Code (IBC)	Maximum Travel distance of 300 feet (91.4400mm)
NFPA 150	Exit travel distances shall not exceed 30m in sprinklered animal housing facilities. Exit travel distances shall not exceed 23m in non-sprinklered animal housing facilities.
New South Wales	60m for farm buildings. The maximum distance from a point on the floor to a point from which travel in different directions to 2 exits is available shall remain at 20m.
South Australia	60m with maximum distance to point of choice remaining at 20m. The path of travel to an exit can incorporate a fixed platform, walkway, stairway, ladder and riser, handrail, balustrade or other barrier attached thereto complying with AS1657.

7.3 Analysis

7.3.1 *RSET Determination – Occupant Evacuation*

The ASET will be compared with the Required Safe Egress Time (RSET) which is determined from the time it takes from fire initiation for occupants to reach a place of safety. Typically, the Required Safe Evacuation Time (RSET) is considered as follows:

Required Safe Egress Time (RSET) = T^1+ T^2+ (T^3+SF2)

Where

Alarm Time (includes visual cue):	T^1 seconds
Pre-movement Time:	T^2 seconds
Travel Time (including Queuing Time):	T^3 seconds
Safety Factor 2:	SF2

Input parameters used in the analysis typically follow the approach given in British Standard BS7974 Part 6.

Alarm Time

It is assumed that occupants become aware of a fire in the farm building by cue via their senses, (i.e. they can see or smell smoke). On this basis, time for a visual cue T^1, is calculated based on 5% [20] of the ceiling height for the various scenarios, however due to the simplistic nature of CFAST modelling, showing less conservative results, the higher value of the lowest ceiling height is used in the closed building scenarios. Refer to Table 19.

Pre-movement Time

Considering the farm buildings will have a management process and regular staff generally present while they are occupied, occupants are considered to be familiar with the exits and way finding would generally be straightforward. On this basis, the pre-movement time travel time, T^2 is considered reasonable at 10 seconds.

Travel Time

The travel time will be based on the speeds and flow rates recommended by SFPE Handbook [10]. An average un-congested walking velocity of 1.25m/s is recommended for egress movement on level ground for occupants without impaired related movement. A speed of 1m/s will be used to allow for reasonable walking speed, to be conservative. Travel time for 60m would be assumed as 60 seconds.

Travel Distance Safety Factor Applied

A maximum direct travel distance analysed is taken as 60m as per concession in QDC Part 3.7. On this basis, a safety factor applied to the travel time is (T^3+SF2), which is 120 seconds *(i.e.60sec + 60sec)* respectively. In comparison to this, safety factors are not applied in standard Deemed to satisfy design.

7.3.2 ASET Determination

Based on the IFEG, tenability for occupant life safety is assessed on the following conditions not endangering human life:

- Temperature
- Level of visibility

For the purpose of this project, the limits of acceptability will be as follows:

Occupant Tenability Criteria 1 - Smoke Layer ≥ 2.1m

Fire Engineering Design Guide [i] suggests that the acceptance radiant heat from the upper smoke layer at the head height (2.1m above the floor level) should not exceed 2.5kW/m^2 which corresponds to the average upper smoke temperature of 200˚C). Therefore, the adopted acceptance criteria are:

- When smoke layer height drops to ≥ 2.1m, radiant heat at head height (2.1m AFFL) shall be ≤ 2.5kW/m^2 (or ≤ 200˚C)

Occupant Tenability Criteria 2 - Smoke Layer < 2.1m

The maximum tolerance temperature of air where people are exposed within the smoke layer (i.e. smoke layer height less than 2.1 m) is set to be 60˚C. For air temperatures above 60˚C and up to 100˚C, the time to incapacitation will be determined by the SFPE Handbook Fractional Incapacitation Dose Model.

Generally, the visibility must not be less than 10m for large rooms in the main egress routes to enable the escape route to be determined which would provide reasonable way finding and avoid toxicity problems. In small rooms, the visibility can be reduced to not less than 5 m.

Therefore, the adopted acceptance criteria are:

- For the smoke layer height < 2.1m, the smoke temperature shall be ≤ 60˚C, and
- Generally, the visibility in main evacuation routes shall be greater or equal to 10 m for large rooms

The criteria is illustrated below

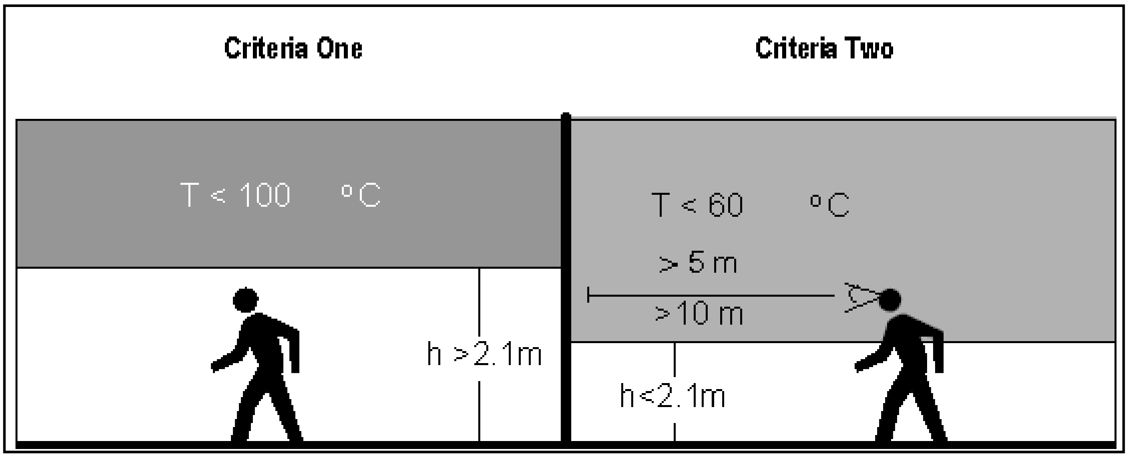


Figure 47: Tenability Criteria

Tenable conditions in evacuation route are expected to be maintained for the period of time occupants take to evacuate that part of the building. ASET/RSET Modelling results are summarised in Table 19 below:

Table 19: Quantification of ASET/RSET Results

Fire Scenario	Building	T^1 Alarm Time (Smoke Layer 5% of ceiling height)	$T^2 + T^3$ = RSET (Response Time + 60m travel distance x SF2)	ASET (Section 6)	ASET vs RSET (60m x SF2)	Compare DTS (40m travel distance x SF2)
Farm Building with Floor Area of 1000m²						
Scenario 1	**Slow t² Fire with 3m ceiling height**	200 sec	(+130s) = **330 sec** [DTS = 200+90sec]	**620 sec**	PASS 620 > RSET 330	DTS = PASS 620 > RSET 290
Scenario 2	**Slow** t² Fire with 6m ceiling height	100sec result (200sec used)	(+130s) = **330sec**	**850 sec**	PASS 850 > RSET 330	DTS = PASS 850 > RSET 290
Scenario 3	**Slow** t² Fire with 9m ceiling height	100sec result (200sec used)	(+130s) = 330 sec	**910 sec**	PASS 910 > RSET 330	DTS = PASS 910 > RSET 290
Scenario 4	**Slow** t² Fire with 12m ceiling height	100sec result (200sec used)	(+130s) = 330 sec	**940 sec**	PASS 940 > RSET 330	DTS = PASS 940 > RSET 290
Scenario 5	**Slow t²** Fire **open walled** with 3m ceiling height	310 sec	(+130s) = 440 sec [DTS = 310+90sec]	**1150 sec**	PASS 1150 > RSET 440	DTS = PASS 1150 > RSET 400
Scenario 6	**Slow** t² Fire **open walled** with 6m ceiling height	120sec result (310sec used)	(+130s) = 440 sec	**1730 sec**	PASS 1730 > RSET 440	DTS = PASS 1730 > RSET 400
Scenario 7	**Slow** t² Fire **open walled** with 9m ceiling height	100sec result (310sec used)	(+130s) = 440 sec	**>1800 sec**	PASS 1800 > RSET 440	DTS = PASS 1800 > RSET 400
Scenario 8	Slow t² Fire **open walled** with 12m ceiling height	110sec result (310sec used)	(+130s) = 440 sec	**>1800 sec**	PASS 1800 > RSET 440	DTS = PASS 1800 > RSET 400
Scenario 9	**Medium t² Fire with 3m ceiling height**	160 sec	(+130s) = 290 sec [DTS = 160+90sec]	**400 sec**	PASS 400 > RSET 290	DTS = PASS 400 > RSET 250

Fire Scenario	**Building**	**T^1 Alarm Time (Smoke Layer 5% of ceiling height)**	**$T^2 + T^3$ = RSET (Response Time + 60m travel distance SF2)**	**ASET** (Section 6)	**ASET vs RSET (60m x SF2)**	**Compare DTS (40m travel distance x SF2)**
Scenario 10	Medium t^2 Fire with 6m ceiling height	80sec result (160sec used)	(+130s) = 290 sec	**570 sec**	PASS 570 > RSET 290	DTS = PASS 570 > RSET 250
Scenario 11	Medium t^2 Fire with 9m ceiling height	70sec result (160sec used)	(+130s) = 290 sec	**610 sec**	PASS 610 > RSET 290	DTS = PASS 610 > REST 250
Scenario 12	Medium t^2 Fire with 12m ceiling height	60sec result (160sec used)	(+130s) = 290 sec	**640 sec**	PASS 640 > RSET 290	DTS = PASS 640 > RSET 250
Scenario 13	**Medium t^2** Fire **open walled** with 3m ceiling height	240 sec	(+130s) = 370 sec [DTS = 240+90sec]	**600 sec**	PASS 600 > RSET 370	DTS = PASS 600 > RSET 330
Scenario 14	Medium t^2 Fire **open walled** with 6m ceiling height	80sec result (240sec used)	(+130s) = 370 sec	**890 sec**	PASS 890 > RSET 370	DTS = PASS 890 > RSET 330
Scenario 15	Medium t^2 Fire **open walled** with 9m ceiling height	70sec result (240sec used)	(+130s) = 370 sec	**1260 sec**	PASS 1260 > RSET 370	DTS = PASS 1260 > RSET 330
Scenario 16	Medium t^2 Fire **open walled** with 12m ceiling height	70sec result (240sec used)	(+130s) = 370 sec	**1670 sec**	PASS 1670 > RSET 370	DTS = PASS 1670 > RSET 330
Scenario 17	**Fast t^2 Fire with 3m ceiling height**	120 sec	(+130s) = 250 sec [DTS = 120+90sec]	**270 sec**	PASS 270 > RSET 250	DTS = PASS 270 > RSET 210
Scenario 18	**Fast** t^2 Fire with 6m ceiling height	60sec result (120sec used)	(+130s) = 250 sec	**380 sec**	PASS 380 > RSET 250	DTS = PASS 380 > RSET 210
Scenario 19	**Fast** t^2 Fire with 9m ceiling height	50sec result (120sec used)	(+130s) = 250 sec	**410 sec**	PASS 410 > RSET 250	DTS = PASS 410 > RSET 210
Scenario 20	**Fast** t^2 Fire with 12m ceiling height	40sec result (120sec used)	(+130s) = 250 sec	**430 sec**	PASS 430 > RSET 250	DTS = PASS 430 > RSET 210
Scenario 21	**Fast t^2** Fire **open walled** with 3m ceiling height	160 sec	(+130s) = 290 sec [DTS = 160+90sec]	**310 sec**	PASS 310 > RSET 290	DTS = PASS 310 > RSET 250
Scenario 22	**Fast t^2** Fire **open walled** with 6m ceiling height	60sec result (160sec used)	(+130s) = 290 sec	**460 sec**	PASS 460 > RSET 290	DTS = PASS 460 > RSET 250
Scenario 23	**Fast** t^2 Fire **open walled** with 9m ceiling height	50sec result (160sec used)	(+130s) = 290 sec	**650 sec**	PASS 650 > RSET 290	DTS = PASS 650 > RSET 250
Scenario 24	**Fast** t^2 Fire **open walled** with 12m ceiling height	50sec result (160sec used)	(+130s) = 290 sec	**850 sec**	PASS 850 > RSET 290	DTS = PASS 850 > RSET 250
Scenario 25	**Ultrafast t^2 Fire with 3m ceiling height**	**80 sec**	(+130s) = 210 sec [DTS = 80+90sec]	**180 sec**	**FAIL** 180 < RSET 210	DTS = PASS 180 > RSET 170

Fire Scenario	Building	T^1 Alarm Time (Smoke Layer 5% of ceiling height)	$T^2 + T^3$ = RSET (Response Time + 60m travel distance x SF2)	ASET (Section 6)	ASET vs RSET (60m x SF2)	Compare DTS (40m travel distance x SF2)
Scenario 26	**Ultrafast t^2** Fire with 6m ceiling height	50sec result (80sec used)	(+130s) = 210 sec	**250 sec**	PASS 250 > RSET 210	DTS = PASS 250 > RSET 170
Scenario 27	**Ultrafast t^2** Fire with 9m ceiling height	40sec result (80sec used)	(+130s) = 210 sec	**280 sec**	PASS 280 > RSET 210	DTS = PASS 280 > RSET 170
Scenario 28	**Ultrafast** t^2 Fire with 12m ceiling height	30sec result (80sec used)	(+130s) = 210 sec	**300 sec**	PASS 300 > RSET 210	DTS = PASS 300 > RSET 170
Scenario 29	**Ultrafast t^2** Fire **open walled** with 3m ceiling height	**100 sec**	(+130s) = 230 sec [DTS = 100+90sec]	**160 sec**	**FAIL** 160 < RSET 230	PASS (**Incl SF2**) 160 ~ RSET 190
Scenario 30	**Ultrafast t^2** Fire **open walled** with 6m ceiling height	50sec result (100sec used)	(+130s) = 230 sec	**240 sec**	PASS 240 > RSET 230	DTS = PASS 240 > RSET 190
Scenario 31	**Ultrafast t^2** Fire **open walled** with 9m ceiling height	30sec result (100sec used)	(+130s) = 230 sec	**330 sec**	PASS 330 > RSET 230	DTS = PASS 330 > RSET 190
Scenario 32	**Ultrafast** t^2 Fire **open walled** with 12m ceiling height	30sec result (100sec used)	(+130s) = 230 sec	**440 sec**	PASS 440 > RSET 230	DTS = PASS 440 > RSET 190
Farm Building with Floor Area of 2000m^2						
Scenario 33	**Slow t^2 Fire with 3m ceiling height**	**300 sec**	(+130s) = 430 sec [DTS = 300+90sec]	**860 sec**	PASS 860 > RSET 430	DTS = PASS 860 > RSET 390
Scenario 34	Slow t^2 Fire with 6m ceiling height	160sec result (300sec used)	(+130s) = 430 sec	**1190 sec**	PASS 1190 > RSET 430	DTS = PASS 1190 > RSET 390
Scenario 35	Slow t^2 Fire with 9m ceiling height	140sec result (300sec used)	(+130s) = 430 sec	**1270 sec**	PASS 1270 > RSET 430	DTS = PASS 1270 > RSET 390
Scenario 36	Slow t^2 Fire with 12m ceiling height	130sec result (300sec used)	(+130s) = 430 sec	**1320 sec**	PASS 1320 > RSET 430	DTS = PASS 1320 > RSET 390
Scenario 37	**Slow t^2 Fire open walled with 3m ceiling height**	**420 sec**	(+130s) = 550 sec [DTS = 420+90sec]	**1530 sec**	PASS 1530 > RSET 550	DTS = PASS 1530 > RSET 510
Scenario 38	**Slow** t^2 Fire **open walled** with 6m ceiling height	180sec result (420sec used)	(+130s) = 550 sec	**>1800 sec**	PASS 1800 > RSET 550	DTS = PASS 1800 > RSET 510
Scenario 39	**Slow** t^2 Fire **open walled** with 9m ceiling height	150sec result (420sec used)	(+130s) = 550 sec	**>1800 sec**	PASS 1800 > RSET 550	DTS = PASS 1800 > RSET 510
Scenario 40	**Slow** t^2 Fire **open walled** with 12m ceiling height	140sec result (420sec used)	(+130s) = 550 sec	**>1800 sec**	PASS 1800 > RSET 550	DTS = PASS 1800 > RSET 510

Fire Scenario	Building	T^1 Alarm Time (Smoke Layer 5% of ceiling height)	$T^2 + T^3$ = RSET (Response Time + 60m travel distance x SF2)	ASET (Section 6)	ASET vs RSET (60m x SF2)	Compare DTS (40m travel distance x SF2)
Scenario 41	**Medium t² Fire with 3m ceiling height**	**240 sec**	(+130s) = 370 sec [DTS = 240+90sec]	**550 sec**	PASS 550 > RSET 370	DTS = PASS 550 > RSET 330
Scenario 42	Medium t² Fire with 6m ceiling height	130sec result (240sec used)	(+130s) = 370 sec	**790 sec**	PASS 790 > RSET 370	DTS = PASS 790 > RSET 330
Scenario 43	Medium t² Fire with 9m ceiling height	100sec result (240sec used)	(+130s) = 370 sec	**850 sec**	PASS 850 > RSET 370	DTS = PASS 850 > RSET 330
Scenario 44	Medium t² Fire with 12m ceiling height	90sec result (240sec used)	(+130s) = 370 sec	**890 sec**	PASS 890 > RSET 370	DTS = PASS 890 > RSET 370
Scenario 45	**Medium t² Fire open walled with 3m ceiling height**	**290 sec**	(+130s) = 420 sec [DTS = 290+90sec]	**790 sec**	PASS 790 > RSET 420	DTS = PASS 790 > RSET 380
Scenario 46	**Medium** t² Fire **open walled** with 6m ceiling height	150sec result (290sec used)	(+130s) = 420 sec	**1070 sec**	PASS 1070 > RSET 420	DTS = PASS 1070 > RSET 380
Scenario 47	**Medium** t² Fire **open walled** with 9m ceiling height	110sec result (290sec used)	(+130s) = 420 sec	**1430 sec**	PASS 1430 > RSET 420	DTS = PASS 1430 > RSET 380
Scenario 48	**Medium** t² Fire **open walled** with 12m ceiling height	80sec result (290sec used)	(+130s) = 420 sec	**1800 sec**	PASS 1800 > RSET 420	DTS = PASS 1800 > RSET 380
Scenario 49	**Fast t² Fire with 3m ceiling height**	**170 sec**	(+130s) = 300 sec [DTS = 170+90sec]	**360 sec**	PASS 360 > RSET 300	DTS = PASS 360 > RSET 260
Scenario 50	**Fast** t² Fire with 6m ceiling height	100sec result (170sec used)	(+130s) = 300 sec	**520 sec**	PASS 520 > RSET 300	DTS = PASS 520 > RSET 260
Scenario 51	**Fast** t² Fire with 9m ceiling height	80sec result (170sec used)	(+130s) = 300 sec	**570 sec**	PASS 570 > RSET 300	DTS = PASS 570 > RSET 260
Scenario 52	**Fast** t² Fire with 12m ceiling height	70sec result (170sec used)	(+130s) = 300 sec	**600 sec**	PASS 600 > RSET 300	DTS = PASS 600 > RSET 260
Scenario 53	**Fast t² Fire open walled with 3m ceiling height**	**210 sec**	(+130s) = 340 sec [DTS = 210+90sec]	**410 sec**	PASS 410 > RSET 340	DTS = PASS 410 > RSET 300
Scenario 54	**Fast** t² Fire **open walled** with 6m ceiling height	110sec result (210sec used)	(+130s) = 340 sec	**550 sec**	PASS 550 > RSET 340	DTS = PASS 550 > RSET 300
Scenario 55	**Fast** t² Fire **open walled** with 9m ceiling height	80sec result (210sec used)	(+130s) = 340 sec	**740 sec**	PASS 740 > RSET 340	DTS = PASS 740 > RSET 300
Scenario 56	Fast t² Fire **open walled** with 12m ceiling height	70sec result (210sec used)	(+130s) = 340 sec	**940 sec**	PASS 940 > RSET 340	DTS = PASS 940 > RSET 300

Fire Scenario	Building	T1 Alarm Time (Smoke Layer 5% of ceiling height)	T2 + T3 = RSET (Response Time + 60m travel distance x SF2)	ASET (Section 6)	ASET vs RSET (60m x SF2)	Compare DTS (40m travel distance x SF2)
Scenario 57	**Ultrafast t² Fire with 3m ceiling height**	**120 sec**	(+130s) = 250 sec [DTS = 120+90sec]	**230 sec**	**FAIL** 230 < RSET 250	DTS = PASS 230 > RSET 210
Scenario 58	**Ultrafast** t² Fire with 6m ceiling height	80 sec (120sec used)	(+130s) = 250 sec	**320 sec**	PASS 320 > RSET 250	DTS = PASS 320 > RSET 210
Scenario 59	**Ultrafast** t² Fire with 9m ceiling height	60 sec (120sec used)	(+130s) = 250 sec	**380 sec**	PASS 380 > RSET 250	DTS = PASS 380 > RSET 210
Scenario 60	Ultrafast t² Fire with 12m ceiling height	50 sec (120sec used)	(+130s) = 250 sec	**400 sec**	PASS 400 > RSET 250	DTS = PASS 400 > RSET 210
Scenario 61	**Ultrafast** t² Fire **open walled** with 3m ceiling height	**130 sec**	(+130s) = 260 sec [DTS = 120+90sec]	**220 sec**	**FAIL** 220 < RSET 260	PASS (Incl SF2) 220 = RSET 220
Scenario 62	**Ultrafast** t² Fire **open walled** with 6m ceiling height	90 sec (130sec used)	(+130s) = 260 sec	**290 sec**	PASS 290 > RSET 260	DTS = PASS 290 > RSET 220
Scenario 63	**Ultrafast** t² Fire **open walled** with 9m ceiling height	60 sec (130sec used)	(+130s) = 260 sec	**380 sec**	PASS 380 > RSET 260	DTS = PASS 380 > RSET 220
Scenario 64	**Ultrafast** t² Fire **open walled** with 12m ceiling height	50 sec (130sec used)	(+130s) = 260 sec	**480 sec**	PASS 480 > RSET 260	DTS = PASS 480 > RSET 220

7.4 Conclusion

The analysis in this section aims to demonstrate qualitatively and quantitatively as to what the ambient conditions in an evacuation route would be during the period of time occupants take to evacuate the building when travel distances are considered in accordance with QDC Part 3.7 proposed concession under A3 – Access and Egress. It is proposed that if the acceptance criteria is satisfied then relevant Performance Requirement will also be satisfied.

Results for QDC Part 3.7 40m / 60m Travel Distances & 80m Between Exits: The results of the fire scenarios analysed, inclusive of a travel distance x 2 safety factor (SF2) as applied for alternative solutions, show that tenable conditions are not always achieved under certain fire growth scenarios commensurate with building size and ceiling height variables. Therefore the proposed concessions to allow an increased travel distance in excess of those specified in the BCA deemed to satisfy provisions, Clauses D 1.4 and D 1.5, is refuted.

Results for BCA-DTS 20m / 40m Travel Distance & 60m Between Exits: The results illustrated in the table above and which are summarised in previous Section 6 show that, based on the same methodology adopted for assessment inclusive of SF2, only 2 fire scenarios relative to building volume and 3m ceiling height, are at the threshold of ASET vs RSET limitation. Since this threshold is very marginal and the results are inclusive of SF2 for travel distance, the adoption of current BCA-DTS 20m / 40m (DTS Clause D1.4) travel distance and 60m between exists (DTS Clause D1.5) should therefore be retained, since it shows better results.

Proposed baffles across doorways: Certain farm buildings would require a baffle across the doorway to facilitate their daily operation. The current proposal of 700mm would be accessible for an able bodied person but unlikely to be suitable for an occupant with disability. The nature of work undertaken in these farms would be more suitable for able bodied occupants and hence the 700mm high door baffle is unlikely to be a hindrance for these able bodied occupants.

8 A4 Fire Fighting Equipment – Fire Hose Reel Systems and Fire Extinguishers

8.1 Purpose

Fire hose reels in buildings allow occupants to fight a fire. The fire may be in its infancy, and early control or extinguishment may reduce the hazard, allow more time for evacuation and prevent structural damage.

Fire extinguishers in buildings allow occupants to fight fires. Extinguishment may complete all the functions listed for fire hose reels.

Both systems are primarily intended for the occupants to undertake fire attack if safe to do so.

The draft QDC Part 3.7 proposal to provide concessions to omit the requirement for fire hose reels is explored in this section.

8.2 Legislation Comparison

The purpose of this section is to provide context into the various first attack equipment (fire hose reels/portable fire extinguishers) requirements considered by different codes/legislation for "farm" building.

Table 20: Legislation comparison for fire hose reel ad fire extinguishers

Name of code/legislation	Fire hose reel / portable fire extinguishers
International Building Code (IBC)	Fire extinguishers required to be installed.
NFPA 150	Fire extinguishers required to be installed.
New South Wales	Farm buildings need not comply with clause E1.4 (Fire hose reels) of Volume 1 of the BCA. Fire extinguishers required.
Victoria, Australia	Fire hose reels are not required for farm buildings. Portable fire extinguishers required in lieu.
South Australia, Australia	Farm buildings need not comply with clause E1.4 (Fire hose reels) of Volume 1 of the BCA. Portable fire extinguishers complying with AS 2444 shall be provided and located as follows: a) One extinguisher rated at not less than 4A60BE (dry chemical powder) at or adjacent to every required exit door. b) Where a room containing flammable materials or electrical equipment (eg a control room) is attached to the building, one extinguisher rated at not less than 5BE (carbon dioxide) in each attached room. c) In open-walled farm buildings (where the spaces between columns are open, and there is no specific exit point for that part of the building), one extinguisher rated at not less than 4A60BE (dry chemical powder) per 500m^2 or part thereof. d) Portable fire extinguishers are not required in hay sheds not exceeding 500m^2 in floor area.
Canada	Fire extinguishers only required.

8.3 Analysis

The fire hose reels are a coiled flexible hose permanently fixed on a reel attached to a wall of a building. Typically fire hose reels are deemed to have a water as the extinguishing medium and provide a water jet of approximately 4m and are required to have provide coverage to the entire building.

The fire extinguishers are categories according to the extinguishing agent and the types of fire on which they can be used, such as:-

- Class A – ordinary combustibles such as wood, paper, plastic etc…
- Class B – Flammable liquids.
- Class C – Flammable gases.
- Class D – Flammable metals.
- Class E – Energised electrical equipment.

Typical extinguishing mediums are as follows:-

- Water – Class A type risks.
- Dry powder (standard) – Class B, C and E
- Dry powder (multi-purpose) – Class A, B, C and E.
- Dry powder (specialised) – Class D
- Carbon di oxide – Class B and E
- Foam (air foam) – Class A and B (except polar solvents).
- Foam (chemical) – Class B (except polar solves).
- Wet chemical – cooking oil and fats.

Fire hose reels and Portable fire extinguishers are both intended as a means of first fire attack by the building occupants if safe to do so.

A comparative study between these two systems is explored further below.

Table 21: Legislation comparison for fire hose reel ad fire extinguishers

Criteria	Fire hose reels	Portable fire extinguishers
Users of equipment	Intended for occupants only to undertake initial fire attack if safe to do so.	Intended for occupants only to undertake initial fire attack if safe to do so.
Purpose	For first fire attack only if safe to do so.	For first fire attack only if safe to do so.
Extinguishing medium	Water	Varies (can be water, foam, dry power etc...)
Duration of availability of extinguishing medium	Unlimited since the fire hose reels will be connected to the site water supply.	Limited to fire extinguisher size.
Hazard specific	No. Hence risk to hose reel user if the user is not trained in hazard risks (such as applying water to live electrical equipment).	Yes Fire extinguishers are selected and located in accordance with the likely hazards anticipated in the area surrounding the fire extinguisher.
Risks	Occupants could potential continue to attack the fire using the fire hose reel for extended periods of time beyond which it would be safe to do so.	Due to the limited extinguishing medium, the occupants will be required to exit the building since fire attack would no longer be feasible.

A quantitative life safety study of various fire sizes has been undertaken and presented in the above sections.

The smoke layer height results for a building with 2000m² floor area is presented below to review the potential impact occupants undertaking first fire attack.

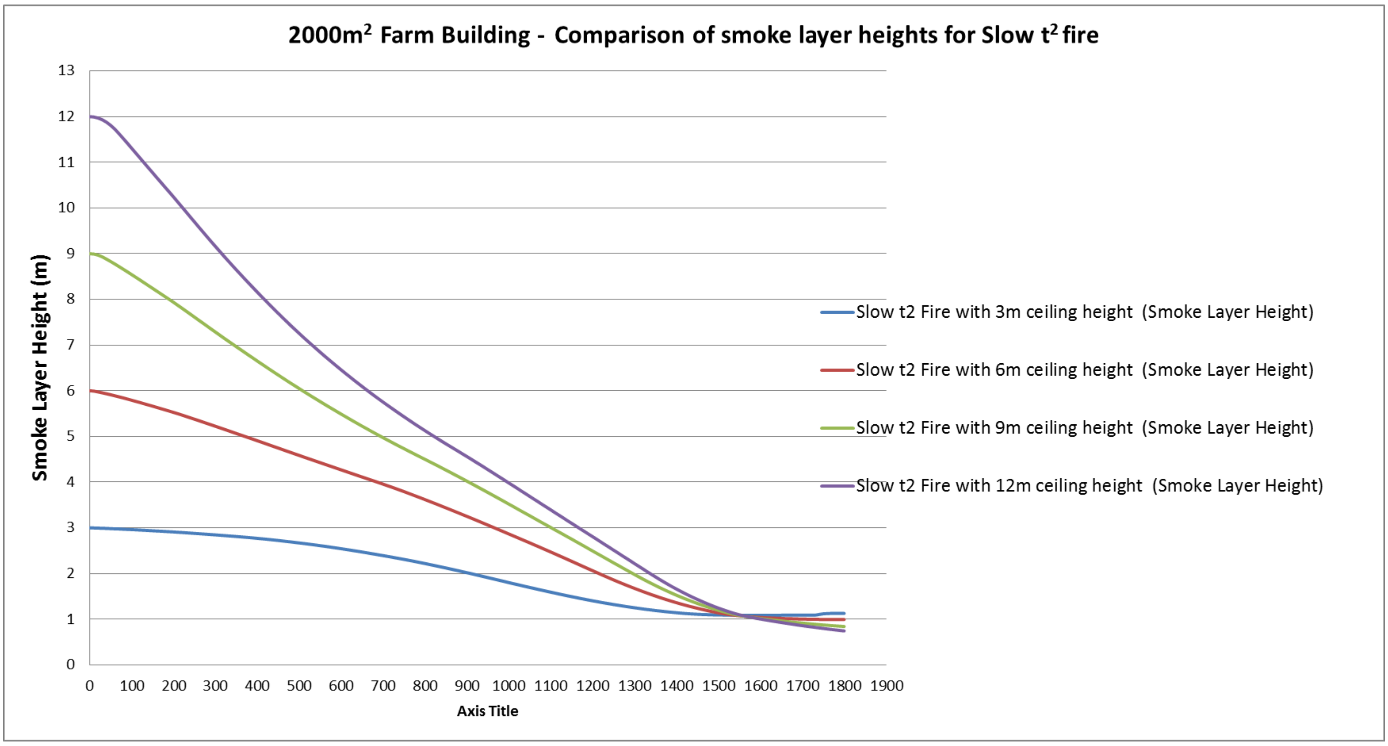


Figure 48: Smoke layer visibility for Slow t² fire within a floor area of 2000m²

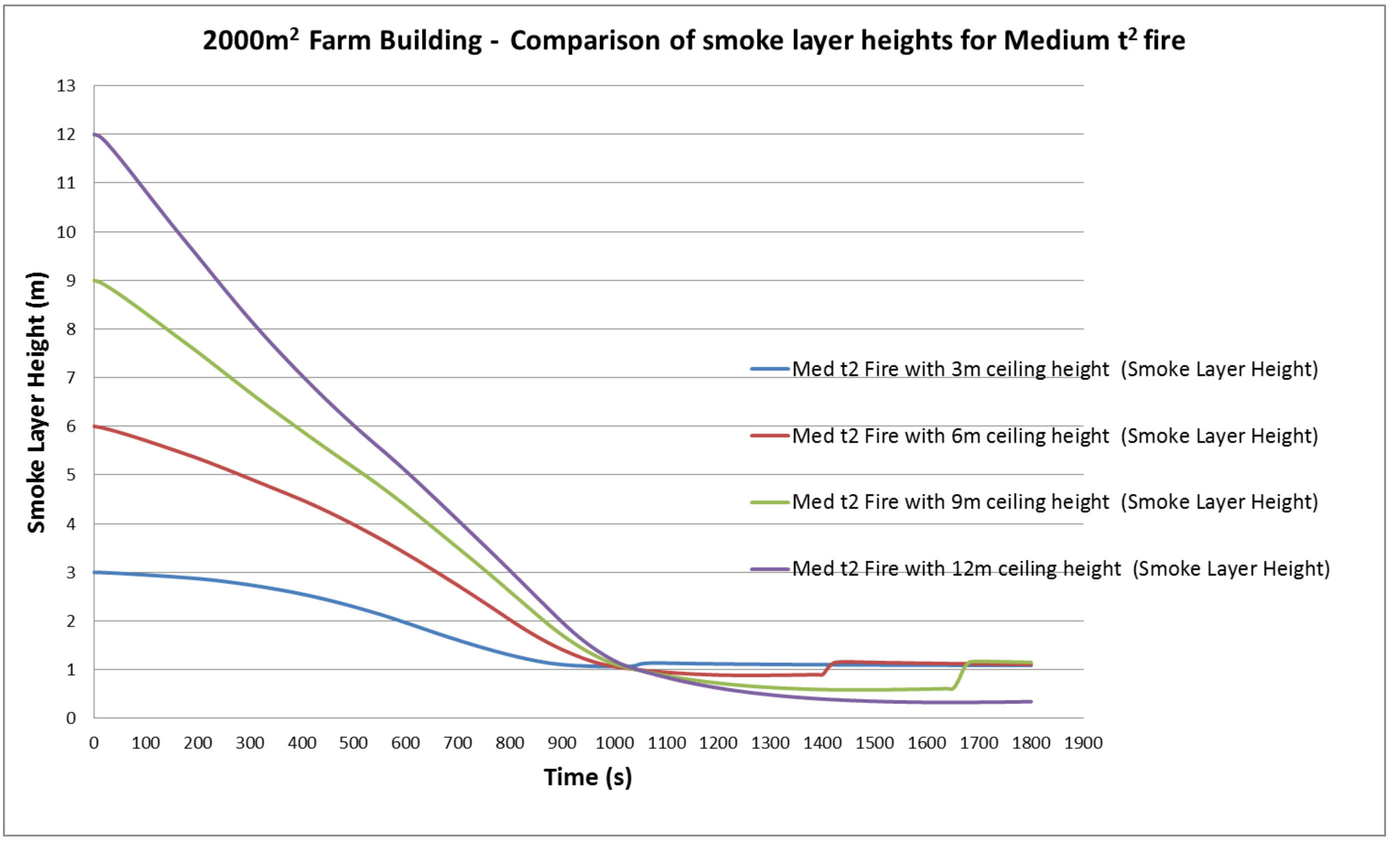


Figure 49: Smoke layer visibility for Medium t² fire within a floor area of 2000m²

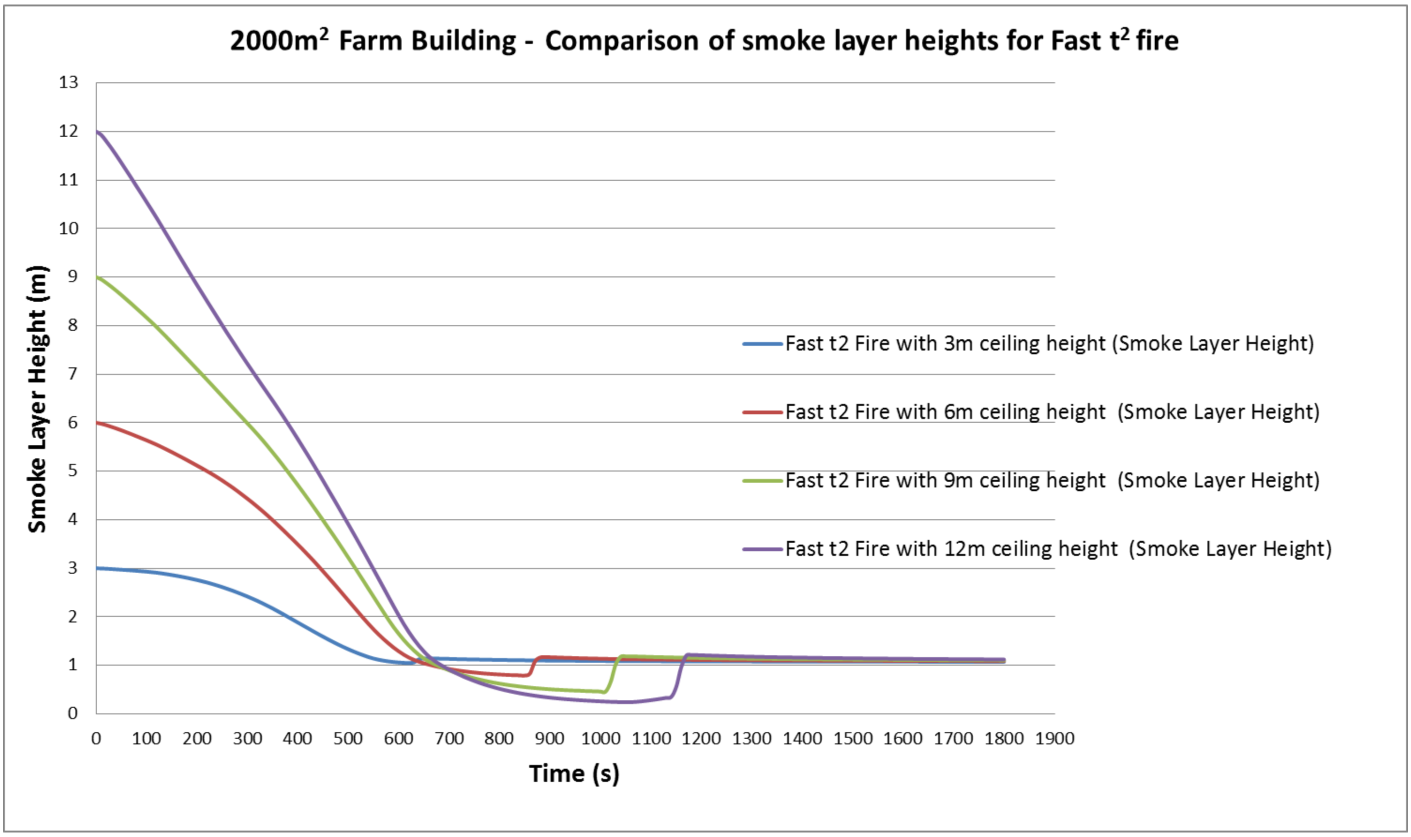


Figure 50: Smoke layer visibility for Fast t^2 fire within a floor area of $2000m^2$

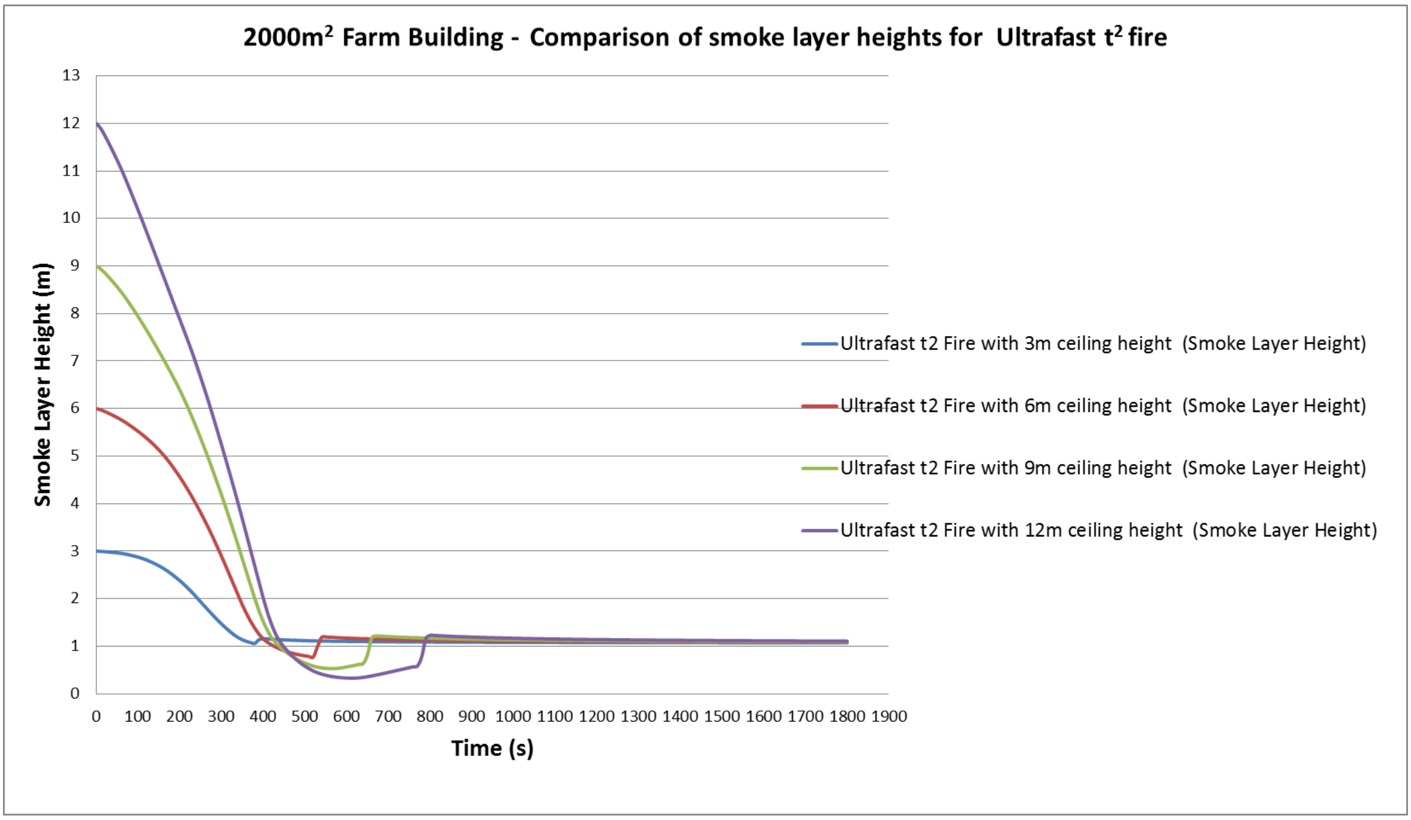


Figure 51: Smoke layer visibility for Ultrafast t^2 fire within a floor area of $2000m^2$

As it can be seen from the above graphs, the amount of time available for the first attack by occupants will vary depending on the type of fire and building geometry.

The farm buildings would have relatively low occupant numbers and high non-human (animals/plants) in the building. The primary purpose of the BCA is occupant life safety and therefore the provision of only fire hose reels as the means of first fire attack would cause the occupants to evacuate the building once the extinguishing medium is emptied on the fire and the fire still continues to burn.

Therefore the draft QDC Part 3.7 proposed concessions to not require fire hose reels in lieu of providing fire extinguishers in specified locations is acceptable.

8.4 Conclusion

The provision of fire extinguishers that are hazard specific as outlined in the draft QDC Part 3.7 is acceptable since it provides a safe means for the occupants to undertake a first fire attack if safe to do so.

It is our view that the draft QDC part 3.7 – acceptable solution A4 (b) (i) for portable fire extinguishers at not less than 5BE (carbon dioxide) must be provided in each room containing flammable materials or electrical equipment, be replaced to ABE fire extinguishers instead. The main reason being, carbon dioxide fire extinguishers are prone to issues such as 1. The fire extinguisher tank being empty due to leak 2. Occupants not trained in the se of these type of fire extinguishers.

9 A5 Fire Fighting Equipment – Fire Hydrant Systems and Fire Water Supply for Fire-Fighting

9.1 Purpose

The purpose of a fire hydrant system is to provide adequate water, under sufficient pressure and flow, to allow the fire brigade to fight fires in an area that is services by the Queensland Fire and Emergency Service.

Therefore the fundamental premise is that the fire brigade are available to service a given farm building only then would a fire hydrant system be required.

The fire crew using the fire hydrant system would use the system for fighting a fire in the building itself or for property protection of adjoining buildings in the vicinity of the building on fire.

9.2 Legislation Comparison

The purpose of this section is to provide context into the various hydrant system and water supply requirements considered by different codes/legislation for "farm" building.

Table 22: Legislation comparison for fire hydrant and water supply

Legislation	Fire hydrant requirements	Water supply
NFPA 150	When required to have sprinkler and hose reels (Hydrants, refer to NFPA 13.)	Approx 1 hour.
New Zealand	When required to hose reels (Hydrants) refer to NZ4541	Approx 1 hour.
Victoria, Australia	Yes required. Below key conditions are to be satisfied a) a water supply for firefighting purposes that complies with sub regulation (4) is available or provided on the allotment on which the farm building is located; and b) the minimum capacity of that water supply is 144 000 litres; and c) subject to sub regulation (5)(c), the water supply is located within 60 metres of the farm building; and d) the water supply is situated so as to enable emergency services vehicles access to within 4 metres of the water supply. Specific requirements for type of water supply and if water storage tank is used specific conditions apply.	144 000 litres (2 hours)
South Australia, Australia	Yes Where fire hydrants are required in accordance with E1.3 of Volume 1 of the BCA, they must be installed in accordance with AS 2419.1, and where relevant, South Australian Fire Services Fire Safety Department Policy Number 0014, except that the following concession is provided for minimum water supply quantity	1 hour
Canada	Yes	Dependent on local authorities.

9.3 Analysis

The location of the farm building has a major impact on the fire crew to be able to undertake firefighting measures. This is mainly due to the distance required to travel to site and the reliance on occupants dialling 000 to notify the fire brigade.

To estimate the firefighting provisions required, likely fire sizes would be required to be analysed. As specified under section P2 – Smoke Hazard Management, multiple fire sizes were selected for analysing the smoke hazard management provisions for occupant life safety.

These fires were based on the standard t^2 growth curves for slow, medium, fast and ultra-fast growth curves wherein the fire grows uncontrolled for a duration of up to 30 minutes. For fast and ultra-fast t^2 growth curves this approach is not fully taken into account due to excessive theoretical fire sizes are unlikely in farm buildings hence fire size was capped at an assumed peak heat release rate of 50MW.

Larger fire sizes may be plausible depending on the extent of the fire load available. Under this approach the fire sizes at different time intervals for these growth rates are tabulated below for ease of reference and information. Taking it into perspective for the benefit of non-technical readers, a typical modern family car when fully involved would generate an average heat release rate fire of 5MW[18] and a typical 4-wheel drive family vehicle averages in the order of 10MW[18].

Table 23: Fire sizes at different time intervals for different growth rates

(Assuming constant un-interrupted fire growth, discounting flashover)

Growth rate	At 5 min from fire start	At 10 min from fire start	At 15 min from fire start	At 20 min from fire start	At 30 min from fire start
Slow t^2 fire	0.2MW	1MW	2.3MW	4.2MW	9.4MW
Medium t^2 fire	1MW	4.2MW	9.4MW	16.8MW	37.9MW
Fast t^2 fire	4MW	16.7MW	37.7MW	67MW Capped at 50MW since excessively large fire sizes are unlikely in farm buildings	150MW Capped at 50MW since excessively large fire sizes are unlikely in farm buildings
Ultra-fast t^2 fire	16.8MW	67.4MW Capped at 50MW since excessively large fire sizes are unlikely in farm buildings	151.7MW Capped at 50MW since excessively large fire sizes are unlikely in farm buildings	Capped at 50MW since excessively large fire sizes are unlikely in farm buildings	Capped at 50MW since excessively large fire sizes are unlikely in farm buildings

The above fire sizes are based on the fire continuing to grow for a specified duration and would have sufficient fuel load and ventilation to support its continued growth.

Due to probability of an extended period in time for fire crews to travel to remote sites, it would be reasonable to state that the fire crew upon arrival would face a fire that is well developed (or in decay stage) and would undertake only external firefighting measures to extinguish the fire and also to protect any structures in the vicinity of the building on fire.

The Australian Fire Authorities Council (AFAC) in table 6.2 and 6.3 of the Fire Brigade Intervention Model V2.2 October 2004 provides the below guidance in regard to the water supply requirements for internal and external firefighting by the fire crew.

Effect of external fire attack

applied water (L/s)	hrr (MW)	110% hrr	90% hrr	cooling capacity (MW)	result:
10	5	5.5	4.5	5.25	constant
20	10	11	9	10.5	constant
30	10	11	9	15.75	decay
40	15	16.5	13.5	21	decay
40	30	33	27	21	no effect

Table 6.3: Effect of water application on heat release rate

Figure 52: Effect of water application on heat release rate [©The Australian Fire Authorities Council (AFAC)]

Based on the AFAC guidance, the use of 20 L/s in water supply would be as a minimum for the fire crew to undertake an external firefighting and property protection measures.

It's most likely that the building on fire would be fully engulfed/damaged by the fire at the time of fire crew arrival. The fire crew would use the water supply available on site for external firefighting and protection of adjacent property on site.

All other specifications in the draft QDC 3.7 acceptable solution A5 pertain to fire crew operational requirements and are acceptable.

9.4 Conclusion

With the current concession provided under acceptable solution 1 of the draft QDC to have no separation between buildings, fire spread to adjacent properties would be likely. In this instance the current proposal of the draft QDC 3.7 to require a minimum water supply of 144000 its onsite water storage capacity (based on 2 hour water supply at 20 L/s) may be adequate for fire crew to undertake firefighting activities.

Hence based on the above the draft QDC acceptable solution A5 is acceptable.

Our view on the onsite water supply storage requirements, is linked with our earlier view on the requirement of minimum separation distance of 6m between buildings to minimise the risk of fire spread between buildings and facilitation of fire crew firefighting activities.

Our key views are as follows:-

1. *If the farm building is located at a distance of more than 30minutes from a local responding fire station, it is unlikely for a fire hydrant system or significant onsite water storage to be of merit for firefighting, except for protection of adjacent buildings or property.*
2. *Assuming minimum separating distances and distance to boundaries are maintained the requirement for a 144000lts water supply for firefighting appears to be onerous. Reducing the water supply demand to 72000lts (1 hour) may be more in line with realistic estimation on anticipated water supply requirements for the fire crew, although this notion would not necessarily be supported by the attending Authority.*
3. *A fire water reservoir or tank capable of 50% - 50% reserve, or reserved water in a single tank dedicated for firefighting, would improve available water supplies in conjunction with the proposed QDC concession.*
4. *The requirement for the onsite water storage tank to be located within 150m of the most distant point of the building (measured along the perimeter of the building) appears to be onerous in terms of application for the farm building operators. Consideration for further consultation with fire brigade to provide further concessions to remove this requirement is recommended. The usage of the onsite storage (such as a distant water reservoir) along with water reticulation being suitable to cater for fire hydrant usage may be further options for consideration.*

10 A6 Emergency Lighting

10.1 Purpose

The purpose of emergency lighting is to provide sufficient visual conditions in a building to aid safe evacuation during an emergency. The guide to the BCA identified three main requirements for the need of emergency lighting. They are:-

- The emergency lighting must be sufficient to minimise the risk of panic;
- The emergency lighting must be sufficient to illuminate the safe route to an emergency exit; and
- The emergency lighting must be sufficient to otherwise assist in the orderly and safe evacuation of the building.

10.2 Legislation Comparison

The purpose of this section is to provide context into the various emergency lighting requirements considered by different codes/legislation for “farm” building.

Table 24: Legislation comparison for emergency lighting requirements

Legislation	Emergency lighting requirements
International Building Code (IBC)	1 Foot candles (11 lux)
NFPA 150	1 Foot candles (11 lux)
Victoria, Australia	Requirement for installation of emergency lighting in farm buildings in removed under two circumstances. The first is where the building has no artificial lighting and the second is where automatic back-up power to supply lighting is provided by a fuel driven back-up generator.
South Australia, Australia	Every emergency lighting system that is required by clause E4.2 of Volume 1 of the BCA to be installed in a Class 7 or Class 8 farm building, must: a. utilise light fittings that comply with the requirements of AS/NZS 2293.1; and b. utilise a 1x36W fluorescent batten light fitting, located at not more than 20m intervals, in both directions (parallel and perpendicular to the light fitting). In Class 7 or Class 8 hay sheds, any area that is used primarily for storage of hay can be excluded when calculating the floor area of the storey or room of the building for the purpose of determining emergency lighting requirements in accordance with E4.2 of Volume 1 of the BCA. Emergency lighting is not required in farm buildings where automatic back-up power is provided by a fuel-driven back-up generator, or where no artificial lighting is provided in the building. Emergency lighting is not required in buildings used only for storage of farm machinery (machinery/implement sheds).
Canada	1 Foot candles (11 lux) required.

10.3 Analysis

The guide to the BCA provides guidance on understanding the requirements for emergency lighting in a building. The guide to the BCA states the follows:-

> *As set out in EP4.1, emergency lighting must be installed when necessary, and be appropriate to a number of factors, including:*
>
> *The use of the building will affect the fire load in the building;*
>
> *The size of the building's floor area which is a measure of the size of any potential fire, and*

The area through which occupants must travel to reach safety; and

The distance of travel to an exit which is a measure of the distance occupants must travel to reach safety (and therefore the time necessary to reach safety).

"Appropriate to"

The lighting must be "appropriate to" the matters listed in EP4.1, which relate to the amount of light in a particular building, and which is necessary to enable evacuation in an emergency.

Examples

Commercial poultry building

- *has a high level of natural light;*
- *is occupied by only a few workers, likely to know the shed well;*
- *is rarely occupied by humans at night;*
- *is without a substantial floor space accessible by humans; and*
- *has short and direct routes to the exit doors.*

In such a case, it may be reasonable for no emergency lighting to be provided

The guide to the BCA is in agreement with the draft QDC 3.7 acceptable solution A6, wherein the use of artificial emergency lighting could adversely affect the behaviours or welfare of the animals kept in the building.

In commercial poultry buildings, there would be certain specific instances when the occupants will be required to work with no natural lighting (*example:- During pick up/collection of chickens from the farm building for transportation). This is done so as to not affect the behaviours or welfare of the chickens kept in the building. However in this instance, the occupants would likely carry a torch to undertake their works (i.e to enter the building and undertake the picking up of chickens*). Further it's likely that these occupants will be familiar with the building and therefore be able to identify exits and traverse obstacles in order to evacuate the building in case of a fire in low light conditions. With the mechanisation of this task, this risk is further reduced in commercial poultry buildings.

10.4 Conclusion

The concession provided in the draft QDC part 3.7 acceptable solution A 6 is in accordance with the guide to the BCA explanation to not require emergency lighting in farm buildings that comply with the draft QDC A8(2)(a).

Hence, it could even be stated that the draft QDC part 3.7 acceptable solution A 6 complies with the intent of the BCA, in that Performance Requirement EP4.1 would be satisfied if ad-hoc artificial lighting (torches and headlamps) are applied.

On this basis, the draft QDC acceptable solution A6 is acceptable.

11 A7 Exit Signs

11.1 Purpose of Sign

The purpose of exit signs within the BCA deemed to satisfy provisions is to provide occupants with a clear and concise information on what route to take to evacuate a building in an emergency.

11.2 Legislation Comparison

The purpose of this section is to provide context into the various exit sign requirements considered by different codes/ legislation for "farm" building.

Table 25: Legislation comparison for exit signs

Legislation	Exit signs
International Building Code (IBC)	Required every 30 meters or Change of Direction.
NFPA 150	Required every 30 meters or Change of Direction.
South Australia, Australia	Luminous exit signs (ie, signs that 'glow in the dark') can be used in intensive animal keeping buildings. Illuminated exit signs must comply with AS/NZS 2293.1.
New South Wales	Required every 60 meters or Change of Direction.
Canada	Required every 30 meters or Change of Direction.

11.3 Analysis

The intent of QDC Part 3.7 under P7 and A7 Exit sign provisions, is NOT to have artificially lit exit light fittings which are constantly illuminated or artificial light sources due to the sensitive nature these would have on intensive animal keeping – for example in poultry sheds that are intentionally dark a light source can cause the birds to respond adversely with potential harm and loss of poultry. The provisions contained in Volume 1 of the BCA are proposed to be deleted (i.e. do not apply) namely:

- E4.5 Exit Signs
- E4.6 Direction Signs
- E4.8 Design an Operation of Exit Signs

The Guide to the BCA states under Part E4, that Performance Requirement EP4.2 uses the term "to the degree necessary" and that the BCA recognises that not all buildings need signs or markers to facilitate evacuation.

The criteria for identification of exits in the Guide to the BCA states that a building proposal must make sure that the means used to identify egress routes and exits are sufficient to enable occupants:

- *to locate the exits;*
- *to find their way to the exits;*
- *to clearly see any signs or other markers; and*
- *to be able to continue to see any signs or markers during their evacuation, in case of a failure of the normal lighting system.*

Examples of what may or may not be suitable exit identification are listed therein is as follows, but that they should not be regarded as absolute:-

A commercial poultry building:

- *has a high level of natural light;*
- *is occupied by only a few workers, who are likely to know the building well;*
- *is rarely, if ever, occupied by people at night, when artificial light is used; and*

- *has direct routes to the exit doors*

In such a case, occupants will be able to easily find the way to the exits. Accordingly, exit signs would not be necessary".

The guide to the BCA is in agreement with the draft QDC 3.7 acceptable solution A7, wherein the use of artificial emergency and exit lighting could adversely affect the behaviours or welfare of the animals kept in the building.

In commercial poultry buildings, there would be certain specific instances when the occupants will be required to work with no natural lighting (*example:- During pick up/collection of chickens from the farm building for transportation). This is done so as to not affect the behaviours or welfare of the chickens kept in the building. However in this instance it is understood that the occupants would likely carry a torch to undertake their works (i.e to enter the building and undertake the picking up of chickens*).

Further it's likely that these occupants carrying out commercial activities will be familiar with the building and therefore be able to identify exits and traverse obstacles in order to evacuate the building in case of a fire in low light conditions. This agrees with the Guide to the BCA as quoted above. With the mechanisation of this task, this risk is further reduced in commercial poultry buildings.

11.4 Conclusion

The concession provided in the draft QDC part 3.7 acceptable solution A 7 is in accordance with the guide to the BCA explanation to not require illuminated (artificially lit) exit signs in farm buildings that comply with the draft QDC A7(2)(a).

Hence it could even be stated that the draft QDC part 3.7 acceptable solution A 7 complies with the intent of the BCA, in that Performance Requirement EP4.2 would be satisfied on the basis described.

On this basis, the draft QDC acceptable solution A7 is acceptable.

Based on the above analysis, it is our view that non-illuminated reflective signs could be used in farm buildings where the occupants will be required to work with no natural lighting. This will provide a means of the occupants if they are disoriented to find an exit.

Passive sign font sizes should follow AS/NZS2293.1 for location in association with viewing distance from the signs. Signs should be checked annually for maintained illuminance and should be replaced as necessary.

12 A8 Artificial Lighting

12.1 Purpose

The purpose of artificial lighting is to enable safe movement of occupants in case of an emergency and to meet the physiological and ethological needs of the animals.

12.2 Analysis

In some farm buildings, no artificial lighting is provided; the operations are all carried out under natural lighting conditions as part of day to day operations.

However, it is proposed for animals kept in buildings not to be kept either in permanent darkness or without an appropriate period of rest from artificial lighting. Where the natural light available is insufficient to meet the physiological and ethological needs of the animals, appropriate artificial lighting must be provided.

The level of artificial lighting must be appropriate to the use of the building to enable safe movement of human occupants so that occupants will be able to quickly identify exits and traverse obstacles in order to obtain quick and efficient egress in case of an emergency.

12.3 Conclusion

In view of the review above:

1) The variation mentioned in subsection applies for a building mentioned in P8.
2) The BCA, volume 1 is varied so the BCA, volume, F4.4 does not apply to the building, if—
    a) the use of artificial lighting in the building could adversely affect the behaviour or welfare of animals kept in the building; or
    b) natural light that enters the building provides the level of illuminance required by FP4.2

Use in conjunction with the “Code of Practice” for Animal Husbandry to define artificial lighting requirements.

The concession is bespoke to farm buildings that operate in low light areas and hence acceptable.

13 A9 Requirements for Vehicle Storage Farm Buildings

13.1 Purpose

Tractors, Harvesters, Forklifts, Trucks, All Terrain Vehicles (ATV), Utility Vehicles, Quad Bikes, Tillage and Seeders, Sprayers, Helicopters and other specialist machinery are used in farms as part of the daily operation activates. These vehicles will require storage in dedicated buildings.

The BCA deems such buildings as Class 7a.

The draft QDC Part 3.7 acceptable solution A9 intent is to allow vehicle storage farm buildings (BCA Class 7a) to be constructed to the requirements as set out for a Farm Building as defined in QDC Part 3.7 i.e. associated with agricultural use. Draft QDC Part 3.7 does not alter the classification of the building, it seeks to alter the applicability of some parts of the BCA that would be applied "as-if" the building were used as a Class 10a but not defined and constructed as Class 10a due to its agricultural related use.

13.2 Analysis

As described above the BCA deems the vehicle storage buildings as a Class 7a. Due to the nature of fire load in these buildings mainly attributed to the vehicles (potentially multiple vehicle fires), plastic products, petrol/LPG, the fuel cans, tyres etc. LPG tanks without the relief valve in older installations provide an increased risk, as a "BLEVE" (Boiled Liquid Evaporation Vapour Explosion) i.e. GAS explosion of a heated of the LPG tank may occur within 10-12 minutes of continuous flame impingement.

A fire in a vehicle storage building are a significant fire hazard due to the heat build-up, the potential risk for fire spread and the need for the firefighting access (if these buildings are located near the boundary).

A BCA class 10a is a non-habitable building being a private garage, carport, shed or the like. The draft QDC part 3.7 intention to treat these farm vehicle storage buildings as equivalent to that of a Class 10a in certain circumstances as outlined in QDC Part 3.7 clause A9 (2) and (3) is noted.

A desktop review of various potential vehicle fires is explored below to provide context into the potential fire sizes that would be likely in these type of buildings:-

- Enclosed Carparks Without Sprinkler Systems, Metropolitan Fire & Emergency Services Board Community Safety Directorate, Version No: 5 4 June 2009, Guideline No: GL-03, Prepared By MFESB Community Safety Advisory Group provides the below information in regard to 2 car and 3 car fires:-

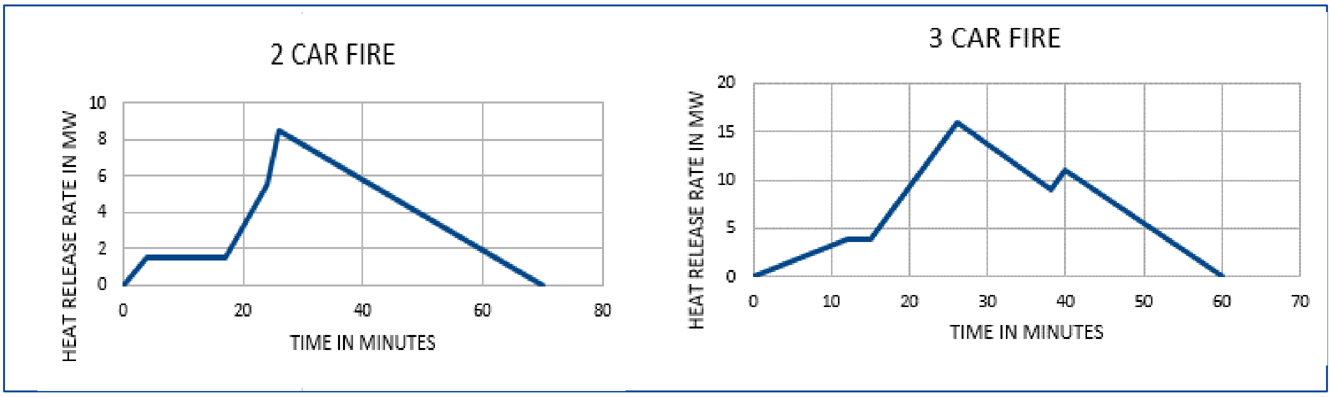


Figure 53: Carpark Fires Data [©Guideline No: GL-03, Prepared By MFESB Community Safety Advisory Group]

- Midsize car free burning, reference: "Development of a database of full-scale calorimeter tests of motor vehicle burns", Final Report, Marc L. Janssens, SwRI Project No. 01.06939.01.003 Report date: March 11 2008.

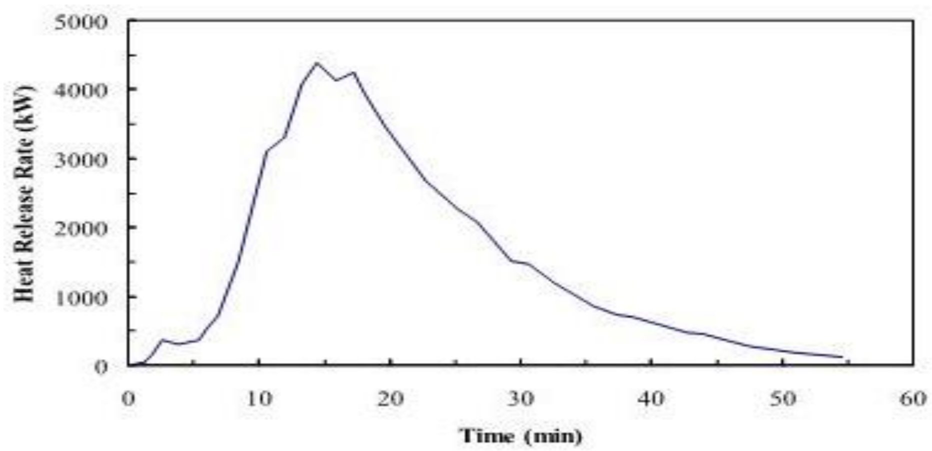


Figure 54: Midsize car free burning Data [©Marc L. Janssens, SwRI Project No. 01.06939.01.003 Report date: March 11 2008.]

- Heavy goods vehicle (HGV), several tests with suppression system except test 7 (free burn). Reference: "Heat Release Rate of Heavy Goods Vehicle Fire in Tunnels with Fixed Water Based Fire-Fighting System", M. K. Cheong, W. O. Cheong, K. W. Leong, A. D. Lemaire and L. M. Noordijk, Springer Science+Business Media New York 2013, Published online: 13 November 2013

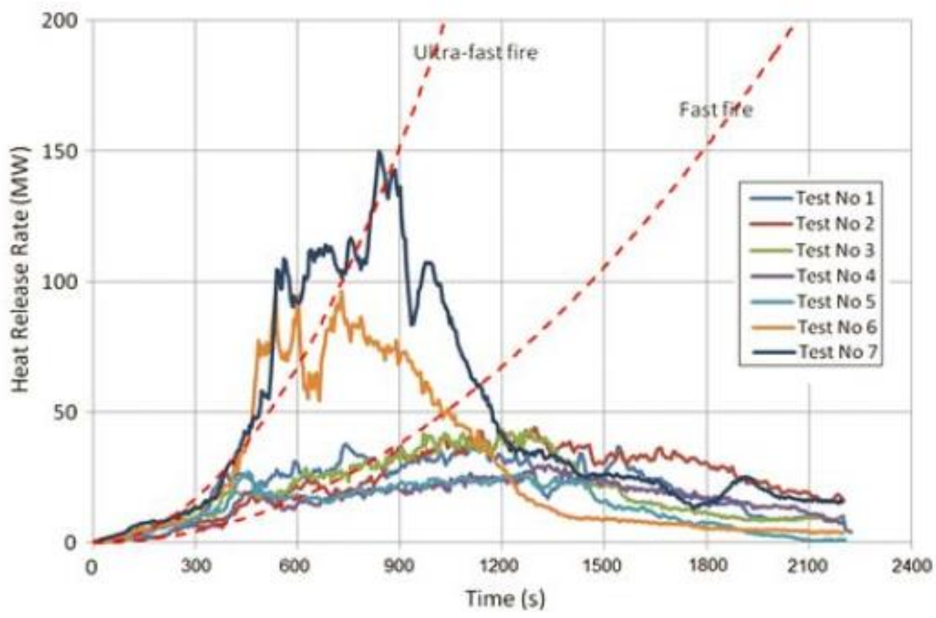


Figure 55: "Heat Release Rate of Heavy Goods Vehicle Fire Data [©Springer Science+Business Media New York 2013, Published online: 13 November 2013]

Fire Spread Analysis

The potential risk of fire spread from a vehicle storage farm building is quantified below to further analyse the proposed acceptable solution A9.

Given the wide range of vehicle storage farm building sizes, the below sizes have been assumed for simplification of the analysis. They cover a floor area from 1000 m² to 2000 m² and a volume from 3000 m³ to 6 000 m³. Larger vehicle storage farm building could potentially be developed, however the results of these buildings would also be applicable to the larger buildings.

Table 26: Range of vehicle storage farm building sizes

Test	Building size in m Length x width x height	Floor area in m²	Volume in m³
1	40m x 25m x 3m	1000 m²	3000 m³
2	50m x 40m x 3m	2000 m²	6000 m³

The intensity of radiation received by a surface remote from an emitter is calculated using the following equation:

$$\dot{q}_R = \emptyset \varepsilon \sigma (273 + T_e)^4$$

Where:

$\emptyset$	=	Configuration factor (value between 0 and 1.0)
ε	=	Emissivity of emitter and absorptivity of receiving surface (value between 0 and 1.0)
σ	=	Stefan Boltzmann constant (5.67 X 10^{-12}(kW/m²/K⁴))

Separation distance

The BCA volume two under clause 3.7.1.6 specifies that an external wall of a Class 10a building which is less than 900mm from an allotment boundary, other than the boundary adjoining a road alignment or other public space, must be provided with an external wall having an FRL of 60/60/60. The construction must comply with the requirements of BCA clause 3.7.1.5.

Therefore for this assessment it is assumed that vehicle storage farm building would be located at 900mm from the site boundary and hence under the current draft QDC part 3.7 would not require any fire protection to its external wall.

Temperatures of radiator

In regard to the temperatures used in this study, a temperature of 500 ºC and 800 ºC has been assumed. These temperatures are reflective of a pre flashover and a post flashover temperatures. These are indicative conservative assumptions.

Acceptance Criteria

The BCA verification method CV1 implies that radiation impact on the building from a fire source feature must not exceed 20 kW/m². Hence for this fire spread analysis, this value will be used as the acceptance criteria.

Quantification

The computational tool used for this analysis is FIREWIND – Radiation. A sample calculation is provided below for ease of reference:-

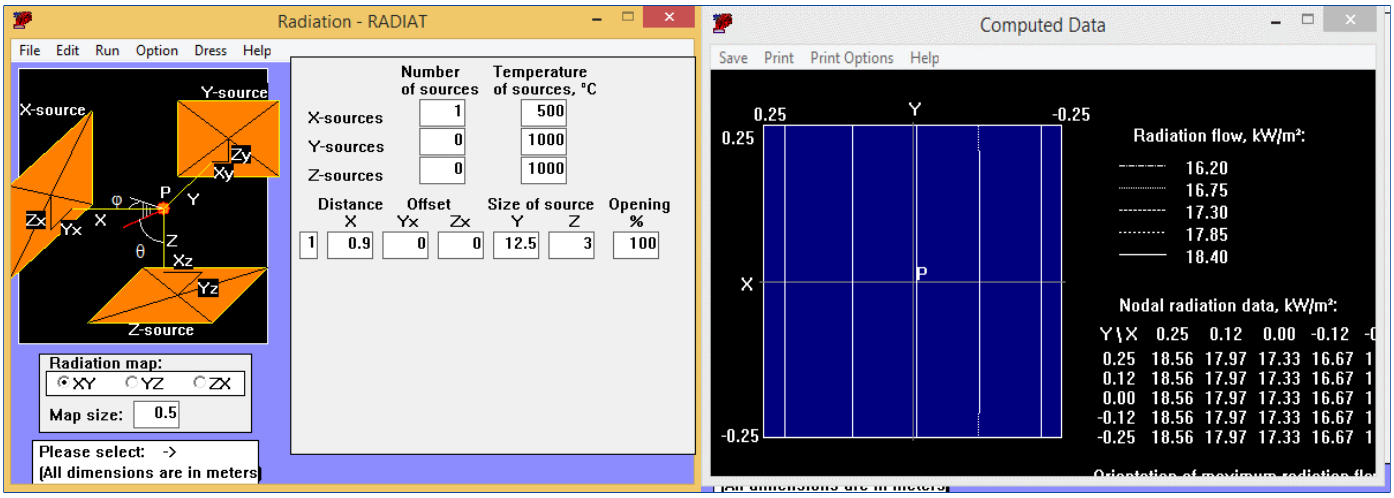


Figure 56: Radiation calculation using FIREWIND Program

The below table has been populated based on the above methodology.

Table 27: Vehicle storage farm building – Summary of radiation calculation

No	Building size in m Length x width x height	Distance from fire source feature	Emmiter temperature (assumed) in °C	Radiator size in m	Calculated heat radiation in kW/m²	Acceptable heat radiation in kW/m²
1	40m x 25m x 3m	0.9m	500 °C	12.5m x 3m	17.33 kW/m²	20 kW/m²
2	50m x 40m x 3m	0.9m	500 °C	20m x 3m	17.36kW/m²	20 kW/m²
3	40m x 25m x 3m	0.9m	800 °C	12.5m x 3m	64.32kW/m²	20 kW/m²
4	50m x 40m x 3m	0.9m	800 °C	20m x 3m	64.43kW/m²	20 kW/m²
5	40m x 25m x 3m	6m	800 °C	12.5m x 3m	15.01kW/m²	20 kW/m²
6	50m x 40m x 3m	6m	800 °C	20m x 3m	17.06kW/m²	20 kW/m²

From the above analysis it is evident that to minimise the potential risk of fire spread from a vehicle storage farm building to the adjacent site, specific fire protection measures in the form of passive fire separation or distance separation would be required.

The requirement for first fire attack via portable fire extinguishers is valid. Refer to the above section "P4 – Fire Fighting Equipment – Fire Hose Reels and Fire Extinguishers" where the potential benefit of using fire extinguishers as the means of first attack by occupants if safe to do is has been explored and supported in this document.

The requirement to comply with BCA Part D3 – Access for People with a Disability is noted and supported.

13.3 Conclusion

Based on the above analysis the proposal under QDC part 3.7 acceptable solution 9 to classify vehicle farm storage buildings as Class 10a would cause an increased risk of fire spread to adjacent properties, increase the risk to the safety of the occupants and safety of the intervening fire crew.

On this basis the draft QDC acceptable solution A9 is refuted.

To facilitate the concession for vehicle storage farm buildings, it is our view that the below items would require consideration:-

- A minimum separation distance of 3m from the property boundary would reduce the potential risk of fire spread, and to that of occupants and fire crew. This would be in accordance with the separation distance requirements for Class 7a buildings as outlined in the BCA.

- A minimum separation distance of 6m between buildings on the same allotment would reduce the potential risk of fire spread, and to that of occupants and fire crew.
- If the physical distance separations cannot be provided, the fire wall will be required to have a minimum fire resistance level of 60/60/60 in line with that of Class 10 buildings as outlined in the BCA volume two.

14 References

1. **England, J.P. [et al.].** *Fire Resistant Barriers and Structures.* Melbourne : Building Control Commission and Warrington Fire Research, 2000.

2. **CIBSE.** *CIBSE Technical Memoranda TM19 - Relationships for Smoke Control Calculations.* London : Chartered Institution of Building Services Engineers, 1995.

3. **National Institute of Standards and Technology.** *CFAST – Consolidated Model of Fire Growth and Smoke Transport (Version 6) - Technical Reference Guide.* Washington D.C. : NIST, 2009.

4. **BFRL-NIST.** *CFAST - Consolidated Model of Fire Growth and Smoke Transport (Version 6).* s.l. : National Institute for Standards and Technology, 2008.

5. **Spearpoint, M.** *Fire Engineering Design Guide (3rd Ed.).* Christchurch, New Zealand : New Zealand Centre for Advanced Engineering, 2008.

6. **ABCB.** *National Construction Code, Volume 1.* Canberra : Australian Building Codes Board, 2014.

7. **State Government of Queensland.** *Queensland Building Act.* 1975.

8. —. *Queensland Building Regulations Subordinate Legislation 2006 No. 280.* 2006.

9. **ABCB.** *International Fire Engineering Guidelines, 1996 Edition.* Canberra : Australian Buildign Codes Board, 1996.

10. **NFPA.** *SFPE Handbook of Fire Protection Engineering (4th Ed.).* Quincy, Massachusetts : National Fire Protection Association, 2008.

11. **National Fire Protection Association.** *Fire Protection Handbook, 18th Ed.* USA : s.n.

12. **Modak, A. T.** *J. of Combustion and Flame (Vol 29) - Radiation from Pool Fires.* s.l. : Journal of Combustion and Flame, 1977.

13. **Buchanan, A. H.** *Fire Engineering Design Guide.* Christchurch, NZ : Centre for Advanced Engineering, 1994.

14. **ABCB.** *The Guide to the Building Code of Australia.* Canberra : Australian Building Codes Board, 2013.

15. —. *International Fire Engineering Guidelines, 2005 Edition.* Canberra : Australian Buildign Codes Board, 2005.

17. **Alujmaiah.I., et al** Wood crib fires under high temperature low oxygen conditions, Energy and resources Research Institute. The University of Leeds, UK.

18**.- J.C. Jones, T. Noonan and M.C. Riordan -** School of Engineering, University of Aberdeen, Aberdeen AB24 3UE, UK – An examination of vehicle fires according to scaling

19. **The National Fire Protection Association Standard NFPA 92B** ‘Guide for Smoke Management Systems in Malls, Atria and Large Areas’

20 **. HIROSHI KOSEKI -** National Research Institute of Fire and Disaster - Fire and Disaster Management Agency - Nakahara, Mitaka, Tokyo, 181-8633 Japan - Large Scale Pool Fires: Results of Recent Experiments

21. **Babrauskas, V.,** in SFPE Handbook of Fire Protection Engineering, 2nd ed., National Fire Protection Association, Quincy , MA, 1995.

22. **The SFPE Handbook of Fire Protection Engineering – 2nd Edition**,’ Section 2 – Chapter 4 Ceiling Jet Flows by David D.Evans’, Editor Philip J. DiNenno, NFPA Publication

Appendix A Glossary of Terminology Used

The following glossary of terminology used in the report are provided based on definitions generally set out in the Australian Building Codes Board 'International Fire Engineering Guidelines' (IFEG). All words listed below are informative and may or may not necessarily apply specifically to this particular report.

AFFL

Above finished floor level

Alternative Solution (Alternative Building Solution)

A Building Solution which complies with the Performance Requirements other than by reason of satisfying the Building Code of Australia (BCA) Deemed-to-Satisfy Provisions.

Assessment Method

A method used for determining that a Building Solution complies with the relevant BCA Performance Requirements.

Available Safe Evacuation Time (ASET)

The time between ignition of a fire and the onset of untenable conditions in a specific part of a building.

Building Code of Australia (BCA), or National Construction Code (NCC)

Relevant building code applicable for design and for construction

Building Solution

A solution which complies with the Performance Requirements and is:

(a) an Alternative Solution; or

(b) a solution which complies with the Deemed-to-Satisfy Provisions; or

(c) a combination of (a) and (b).

A Building Solution will comply with the BCA [1] if it satisfies the Performance Requirements.

DTS - Deemed-to-Satisfy (Provisions)

The prescriptive provisions of a code that are deemed to satisfy the performance requirements.

Design Fire

A mathematical representation of a fire that is characterised by the variation of heat output with time and is used as the basis for assessing fire safety systems.

Design Fire Scenario (also referred as Fire Scenario)

A fire scenario that is used as the basis for a design fire.

Deterministic Method

A methodology based on physical relationships derived from scientific theories and empirical results that for a given set of conditions will always produce the same outcome.

Engineering Judgement

Process exercised by a professional who is qualified because of training, experience and recognised skills to complement, supplement, accept or reject elements of a quantitative analysis.

Evacuation

The process of occupants becoming aware of a fire-related emergency and going through a number of behavioural stages before and/ or while they travel to reach a place of safety, internal or external, to their building.

Fire

The process of combustion once ignition has occurred.

Fire Scenario

The ignition, growth, spread, decay or burnout of a fire in a building as modified by the fire safety system of the building. A fire scenario is described by the times of occurrence of the events that comprise the fire scenario.

Flaming Fire

A fire involving the production of flames (including flashover fires).

Flashover

The rapid transition from a localised fire to the combustion of all exposed surfaces within a room or compartment.

Fuel Load

The quantity of combustible material within a room or compartment measured in terms of calorific value.

Fire Engineering Brief (FEB)

In terms of normal 'due process' a documented process that defines the scope of work for the fire safety engineering analysis and the basis for analysis as agreed by stakeholders, as formally applied for an alternative building solution.

Fire Engineering Report (FER)

A documented which is to detail the analysis, arguments, calculations and modelling used to verify the design meets the relevant Performance Requirements, as formally applied for an alternative building solution.

Fire Safety System

One or any combination of the methods used in a building to:

(a) warn people of an emergency,

(b) provide for safe evacuation,

(c) restrict the spread of fire, or

(d) extinguish a fire.

It includes both active and passive systems.

FBIM

A widely used abbreviation for Fire Brigade Intervention Model. Acceptance criteria for conditions of exposure to fire fighters and response times are considered as outlined in the Queensland Emergency & Rescue Services Guide to the Referral of Alternative Solutions for hazardous conditions.

Hazard

The outcome of a particular set of circumstances that has the potential to give rise to unwanted consequences.

kW/m^2

Abbreviation for kilowatt per square meter, used to reflect a numerical value for thermal radiation

Performance Requirement

A requirement which states the level of performance which a Building Solution must meet.

Place of Safety

A place within a building or within the vicinity of a building, from which people may disperse after escaping the effects of a fire. It may be an open space (such as an open court) or a public space (such as a foyer or roadway.

Qualitative Analysis

Analysis that involves a non-numerical and conceptual evaluation of the identified processes.

Quantitative Analysis

Analysis that involves numerical evaluation of the identified processes.

QDC

Queensland Development Code

Rate of Heat Release

The rate at which heat is released by fire, also referred to as Heat Release Rate, or Heat Release.

Required Safe Evacuation Time (RSET)

The time required for safe evacuation of occupants to a place of safety prior to the onset of untenable conditions.

Response Time

The time it takes occupants to respond to an alarm or other cues generally prior to egress the building. Also used in relation to response time of an active or passive fire system.

Risk

The likelihood of a hazardous event occurring.

Sensitivity Analysis

A guide to the level of accuracy and/or criticality of individual parameters determined by investigating the response of the output parameters to changes in these individual parameters.

Smoke

The airborne solid and liquid particles and gases evolved when a material undergoes pyrolysis or combustion, together with the quantity of air that is entrained or otherwise mixed into the mass.

Smouldering Fire

The solid phase combustion of a material without flames and with smoke and heat production.

Sterile

An environment with no combustible furnishings other than wall or floor linings (i.e. no couches, etc). Spread-of-flame and Smoke-developed indices are to comply with BCA requirements throughout.

Sub-System

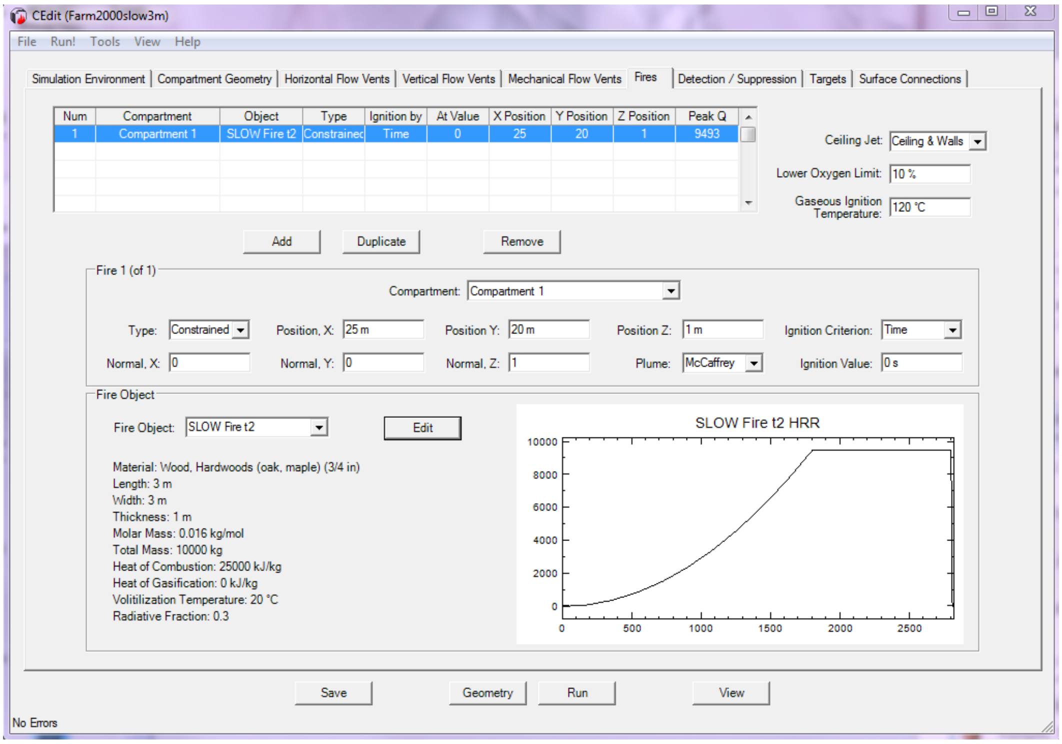
A part of a fire safety system that comprises fire safety measures to protect against a particular hazard (eg smoke spread).

To The Degree Necessary

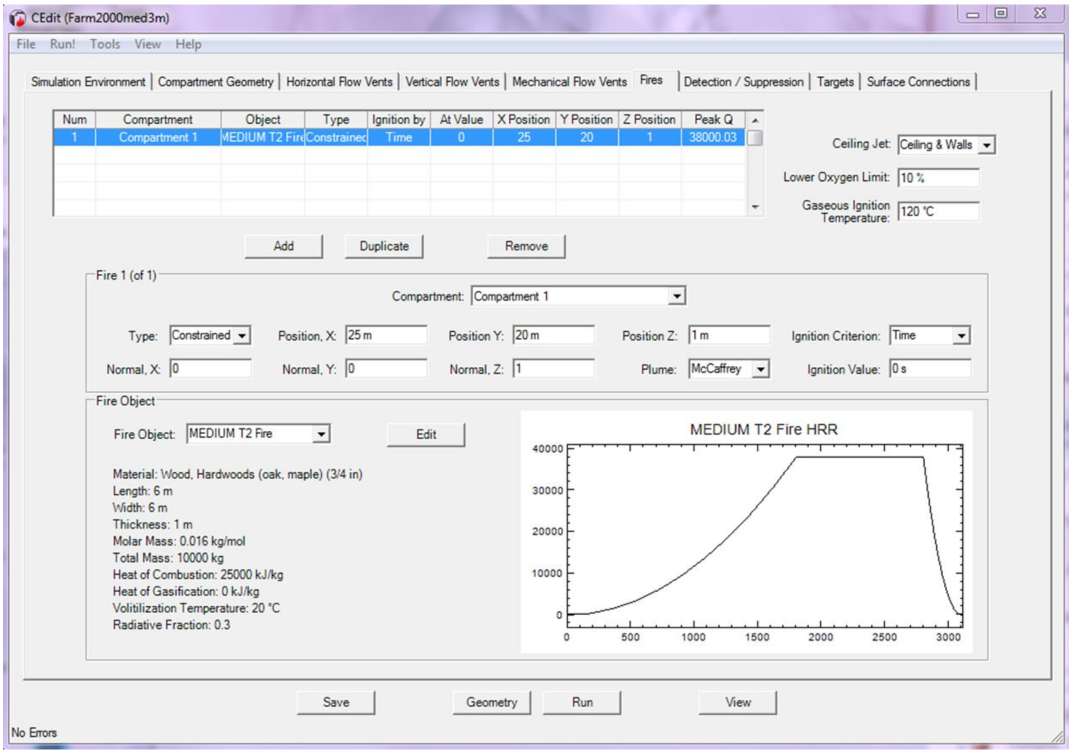
Consideration of all the relevant criteria referred to in the Performance Requirement set out in the BCA to determine the outcome appropriate to the circumstances, whereby in certain situations it may not be necessary to incorporate any specific measures to meet the Performance Requirement.

Appendix B CFAST Fire Growth Curves

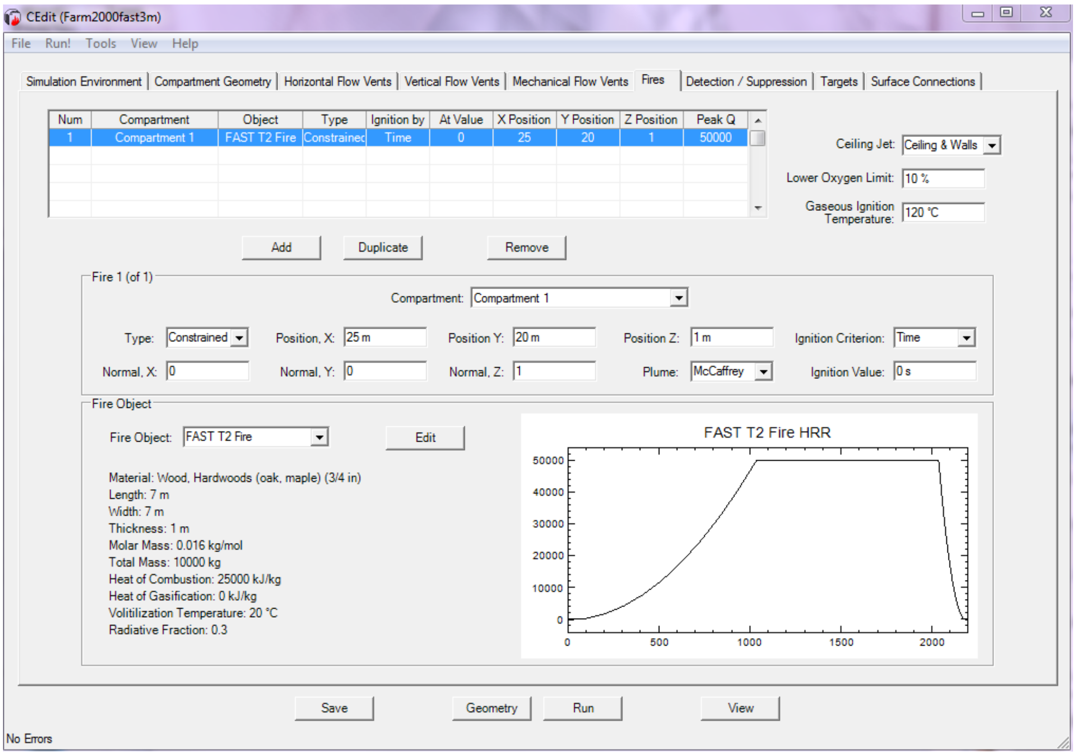
B.1 SLOW t^2 Fire



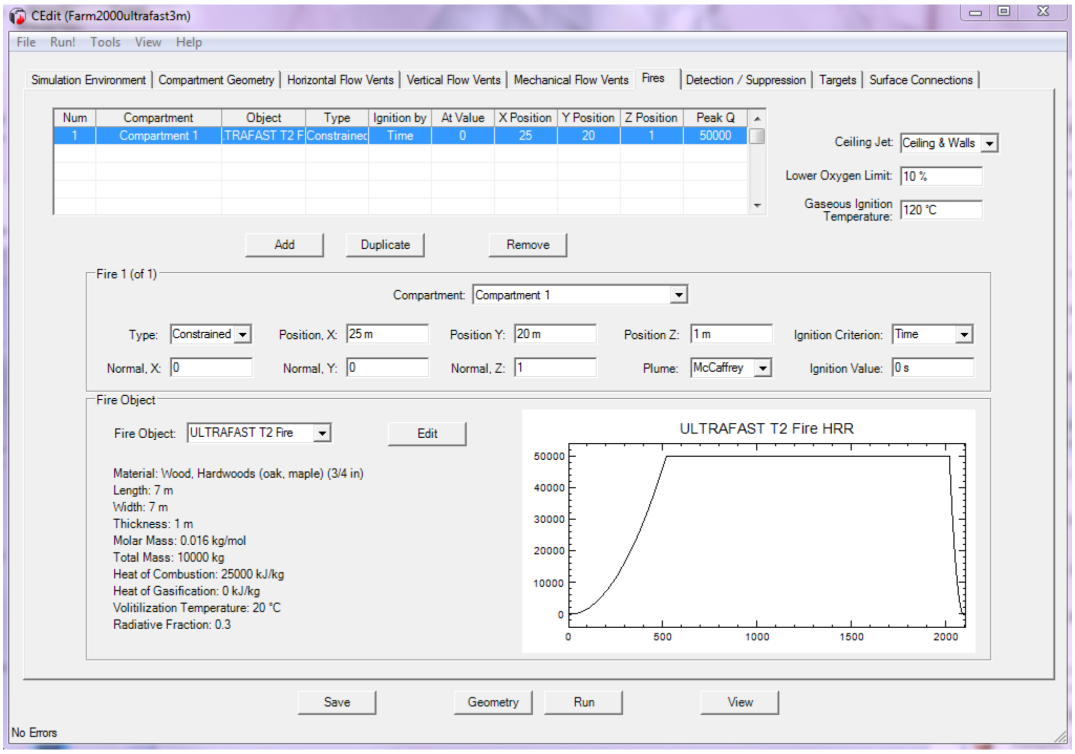
B.2 MEDIUM t^2 Fire



B.3 FAST t^2 Fire



B.4 ULTRAFAST t^2 Fire



Appendix C QDC, Part 3.7 – Farm Buildings (DRAFT)

Queensland Development Code, part 3.7 – farm buildings

Contents

Introductory information

Relationship between the BCA and the QDC

Under section 35 of the *Building Act 1975* (Building Act), if a part of the Queensland Development Code (QDC) is inconsistent with the Building Code of Australia (BCA), the part prevails to the extent of the inconsistency. This section allows the QDC to vary requirements in the BCA for particular buildings, including farm buildings.

The requirements of *Queensland Development Code, part 3.7 – farm buildings* (this QDC part) vary some of the performance requirements and deemed-to-satisfy provisions in the BCA that apply to farm buildings. If a performance requirement or deemed-to-satisfy provision that applies to a farm building under the BCA is not mentioned in, or varied by, chapter 3 of this QDC part, it continues to apply under the BCA.

Compliance with the QDC

Under section 14 of the Building Act, building work complies with the QDC only if it complies with all relevant performance requirements under the QDC. The building work complies with a relevant performance requirement only if it achieves a relevant building solution under the QDC for the performance requirement. This can be achieved by—

(a) complying with the relevant acceptable solution for the performance requirement; or

(b) formulating an alternative solution that complies with the performance requirement or is shown to be at least equivalent to the relevant acceptable solution; or

(c) a combination of paragraphs (a) and (b).

Referral agency

Under the *Sustainable Planning Regulation 2009,* schedule 7, table 1, item 2B, the Queensland Fire and Emergency Services is a referral (advice) agency for a building development application for a farm building, if the application includes an alternative solution assessed against performance requirement P5, in chapter 3 of this QDC part.

Associated requirements

The following legislation includes requirements that are applicable to farm buildings. Those requirements are additional to the requirements in this QDC part.

- *Building Act 1975*
- Building Code of Australia (BCA)
- *Building Regulation 2006*
- *Building Fire Safety Regulation 2008*
- *Sustainable Planning Act 2009*
- *Sustainable Planning Regulation 2009*

Chapter 1 Preliminary

1 Name of QDC part

This part of the *Queensland Development Code* (this QDC part) may be cited as the *Queensland Development Code*, *part 3.7 – farm buildings.*

2 Purpose

The purpose of this QDC part is to vary particular requirements in the *BCA* that apply to *farm buildings*, to ensure the requirements are appropriate for those buildings.

3 Commencement

This QDC part was published on [xxxx] and commences on [xxxx] 2014.

4 Application

(1) This QDC part applies to *building work* for a *building* mentioned in Table 1 as indicated by the crosses in the relevant columns in the table.

(2) However, this QDC part does not apply to the *building work* if a sprinkler system is required to be installed in the *building* under the *BCA*, volume 1, E1.5.

Table 1

Application		**Performance requirements**								
		P1	P2	P3	P4	P5	P6	P7	P8	P9
1	A *high occupancy farm building*				X	X				
2	A *low occupancy farm building*	X	X	X	X	X	X	X	X	
3	A *vehicle storage farm building*									X

Note—

Chapter 3 of this QDC part varies some, but not all, of the performance requirements and deemed-to-satisfy provisions in the *BCA* that apply to *farm buildings*. If a performance requirement or deemed-to-satisfy provision that applies to a *farm building* under the *BCA* is not mentioned in or varied by chapter 3, it continues to apply under the *BCA*.

5 Referenced documents

Table 2 sets out the number, year of commencement and title of Australian Standards referred to elsewhere in this QDC part by their numbers.

Table 2

Number	Year	Title
AS 1657	2013	Fixed Platforms, walkways, stairways and ladders–Design, construction and installation
AS 2293.1, as amended by Amendment No. 1	2005	Emergency escape lighting and exit signs for buildings Part 1: System design, installation and operation
AS 2293.3	2005	Emergency escape lighting and exit signs for buildings Part 3: Emergency escape luminaires and exit signs
AS 2419.1, as amended by Amendment No. 1	2005	Fire hydrant installations, Part 1: System design, installation and commissioning
AS 2444	2001	Portable fire extinguishers and fire blankets – Selection and location

Chapter 2 Interpretation

6 What is a *high occupancy farm building*

A *building* is a ***high occupancy farm building*** if—

(a) it is a *farm building* mentioned in the definition *farm building*, paragraph (a); and

(b) the number of people usually carrying out an *agricultural activity* in the *building* is greater than the maximum number usually doing so in a *low occupancy farm building*.

Note

For the maximum number of people usually carrying out an *agricultural activity* in a *low occupancy farm building*, see section 7(b).

7 What is a *low occupancy farm building*

A *building* is a ***low occupancy farm building*** if—

(a) it is a *farm building* mentioned in the definition *farm building*, paragraph (a); and

(b) the maximum number of people usually carrying out an *agricultural activity* in the *building* is the higher of the following—

(i) 1 person per $200m^2$ of the total floor area of the *building*; or

(ii) 6 persons.

Examples—

1 a *farm building* that is $800m^2$ in which 6 people work

2 a *farm building* that is $2000m^2$ in which 10 people work

8 What is an *open-walled building*

A *building* is an ***open-walled building*** if at least a third of the perimeter of the *building* has no walls.

9 Definitions

acceptable solution see the *Building Act*, section 14.

accessible see the *BCA,* volume 1.

alternative solution see the *Building Act*, schedule 2.

agricultural activity means any of the following activities—

(a) growing, producing or harvesting—

(i) fibre, timber, foliage or similar substances; or

(ii) things intended for human or animal consumption, whether before or after processing; or

(b) animal husbandry;

(c) aquaculture;

(d) dairy farming;

(e) floriculture;

(f) forestry;

(g) horticulture;

(h) intensive insect or animal-keeping;

(i) viticulture.

building see the *Building Act*, schedule 2.

Building Act means the *Building Act 1975*.

Building Code of Australia (BCA) see the *Building Act*, schedule 2.

building work see the *Building Act*, section 5.

class see the *Building Act*, schedule 2.

exit see the *BCA,* volume 1.

farm building means—

(a) a *class* 7 or *class* 8 *building*—

(i) on land used primarily for an *agricultural activity*; and

(ii) in which one or more *agricultural activities* are carried out; or

(b) a *class* 7 or *class* 8 *building*—

(i) on land used primarily for an *agricultural activity*; and

(ii) used primarily to house one or more *farm vehicles* when not in use.

Examples for paragraph (a)—

a *building* used for keeping pigs

a *building* used for packing eggs produced on a chicken farm

a *building* used for the milking of cows kept on a farm

Example for paragraph (b)

a *building* used to house a tractor, harvester, quad bike and utility truck

Note—

There are 3 main types of *farm building* for this QDC part. They are—

- a *low occupancy farm building*
- a *high occupancy farm building*
- a *vehicle storage farm building*.

farm vehicle*,* means a vehicle used—

(a) in connection with an *agricultural activity*; and

(b) on land used primarily for an *agricultural activity*.

Examples—

a tractor, harvester, quad bike or utility truck

fire brigade see the *BCA*, volume 1.

fire compartment see the *BCA*, volume 1.

fire hazard see the *BCA,* volume 1.

fire safety system see the *BCA*, volume 1.

floor area see the *BCA*, volume 1.

high occupancy farm building see section 6.

low occupancy farm building see section 7.

non-illuminated exit sign means an exit sign that complies with the requirements for an externally illuminated exit sign in AS 2293.3:2005, other than clause 3.4.4.

open-walled building see section 8.

QFES see the *Fire and Emergency Services Act 1990*, chapter 3.

Queensland Development Code (QDC) see the *Building Act*, section 13.

required see the *BCA,* volume 1.

type C construction means a *building* that complies with the requirements in the *BCA*, volume 1, specification C1.1, section 5.

vehicle storage farm building means a *building* mentioned in the definition *farm building*, paragraph (b).

Chapter 3 Performance requirements and acceptable solutions

PERFORMANCE REQUIREMENT	ACCEPTABLE SOLUTIONS

Compartmentation and separation

P1 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, CP9.

Note—

P1 applies to particular *low occupancy farm buildings*—see section 4.

A1 (1) The variation mentioned in subsection (2) applies for the *building* if—

(a) the *building* is a *type C construction*; and

(b) the *floor area* of the *building* is more than 2000m^2 but not more than 18 000m^2; and

(c) the volume of the *building* is more than 12 000m^2 but not more than 108 000m^2.

(2) The *BCA*, volume 1, C2.3 is varied so C2.3 (a)(i)(B) is omitted.

Smoke hazard management

P2 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, EP2.2.

Note—

P2 applies to particular *low occupancy farm buildings*—see section 4.

A2 (1) The variation mentioned in subsection (2) applies for the *building* if—

(a) the *building* is a *type C construction*; and

(b) the floor *area* of the *building* is more than 2000m^2 but not more than 18 000m^2; and

(c) the volume of the *building* is more than 12 000m^2 but not more than 108 000m^2.

(2) The *BCA*, part E2 is varied so *Table E2.2a – Large Isolated Buildings Subject to C2.3*, paragraphs (a) (i) to (iv) are omitted.

PERFORMANCE REQUIREMENT		ACCEPTABLE SOLUTIONS	

Access and egress

P3 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, DP1 to DP9.

Note—

P3 applies to particular *low occupancy farm buildings*—see section 4.

A3 The following variations apply for the *building*—

(a) the *BCA*, volume 1, D1.4(c)(i) is varied so the reference in D1.4(c)(i) to—

  (i) '20m' is replaced by a reference to '40m'; and

  (ii) 'exceed 40m' is replaced by a reference to 'exceed 60m'; and

(b) the *BCA*, volume 1, D1.5 is varied so the reference in D1.5(c)(iii) to '60m' is replaced with a reference to '80m'; and

(c) the requirements for a stairway going and riser, landing, balustrade or other barrier, handrail, fixed platform, walkway, stairway or ladder, are those in—

  (i) the *BCA*, volume 1, D2.13, D2.14, D2.16 or D2.17; or

  (ii) AS 1657:2013; and

(d) if an area in the *building* is not required under the *BCA*, volume 1, D3.4 to be *accessible*— the *BCA,* volume 1, D2.15 is varied to allow a baffle in a doorway no higher than 700mm.

Fire fighting equipment – fire hose reel systems and fire extinguishers

P4 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1—

(a) EP1.1; and

A4 The *BCA,* volume 1 is varied for the *building,* so it provides the following alternatives—

(a) the *building* must comply with the *BCA,* volume 1, E1.4 and E1.6; or

PERFORMANCE REQUIREMENT	ACCEPTABLE SOLUTIONS
(b) EP1.2. *Note*— P4 applies to— • particular *high occupancy farm buildings*; and • particular *low occupancy farm buildings*. (See section 4.)	(b) instead of complying with E1.4 and E1.6, the *building* must comply with the following requirements— (i) a portable fire extinguisher rated at not less than 5BE (carbon dioxide) must be provided in each room containing flammable materials or electrical equipment is attached to the *building*; and (ii) either— (A) a portable fire extinguisher rated at not less than 4A60BE (dry chemical powder) must be provided at or adjacent to every *required exit* door; or (B) if the *building* is an *open-walled building*—a portable fire extinguisher, rated at not less than 4A60BE (dry chemical powder), must be provided for each 500m^2 of floor area or part thereof; and (iii) each portable fire extinguisher provided must comply with AS 2444-2001, section 3 (Location of Portable Fire Extinguishers).

PERFORMANCE REQUIREMENT	ACCEPTABLE SOLUTIONS

Fire fighting equipment - fire hydrants and water supply

P5 (1) A fire hydrant system, or a water supply for fire-fighting, must be provided for a *building* to which this performance requirement applies.

(2) The fire hydrant system or water supply must be provided to the degree necessary to facilitate the needs of the *fire brigade* appropriate to—

(a) fire-fighting operations; and

(b) the floor area of the *building*; and

(c) the *fire hazard*.

Notes—

1 P5 varies the *BCA*, volume 1, EP1.3.

2 P5 applies to —

- particular *low occupancy farm buildings*; and
- particular *high occupancy farm buildings*;

(See section 4.)

A5 (1) The *building* must comply with—

(a) the *BCA*, volume 1, E1.3; or

(b) instead of E1.3—

(i) E1.3, varied so the reference in AS 2419.1:2005, section 4 to '4 hours' for water supply is replaced by a reference to '2 hours'; or

(ii) subsection (2) or (3).

(2) The *building* complies with this subsection if it provides an on-site water storage tank that—

(a) complies with AS 2419.1:2005, clause 2.1.3 and section 5 – (Water storage), except clauses 5.2.4, 5.4.3 and 5.4.6; and

(b) provides a minimum capacity of 144 000 litres available for fire-fighting purposes at all times; and

(c) is located within 150m of the most distant point of the building from the tank, measured around the perimeter of the *building*; and

(d) is fitted with a hard suction outlet that—

(i) is located within 10m of the on-site water storage tank; and

(ii) has a lift of no more than 4m; and

(iii) comprises a 50mm

PERFORMANCE REQUIREMENT	ACCEPTABLE SOLUTIONS

ball valve and 50mm male camlock coupling; and

(iv) if the *building* is located within a 40 minute response time from the nearest *QFES* urban or auxiliary fire station—is fitted with a hard suction outlet comprising a female coupling of British Coventry type, having—

(A) a 125mm diameter; and

(B) a thread size of 3 threads per inch.

(3) The *building* complies with this subsection if it provides 2 or more on-site water storage tanks—

(a) each of which complies with the requirements mentioned in subparagraphs (2)(a)(b) and (d); and

(b) located so no point of the *building* is more than 150m from a tank, measured around the perimeter of the *building*, and each tank is within 300m of another tank.

Emergency lighting

P6 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, EP4.1.

A6 (1) The variation mentioned in subsection (2) applies for the *building*.

(2) The *BCA*, volume 1 is varied so

PERFORMANCE REQUIREMENT		ACCEPTABLE SOLUTIONS
Note— P6 applies to particular *low occupancy farm buildings*. (See section 4.)		the *BCA*, volume 1, E4.2, E4.3 and E4.4 do not apply to the *building*, if— (a) no artificial lighting is required to be provided in the *building*, under A8(2)(a); or (b) natural light that enters the *building* provides the level of illumination required by EP4.1.

Exit signs

P7	The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, EP4.2. *Note*— P7 applies to particular *low occupancy farm buildings*. (See section 4.)	**A7**	(1) The variation mentioned in subsection (2) applies for the *building*. (2) The *BCA*, volume 1 is varied so the *BCA*, volume 1, E4.5, E4.6 and E4.8 do not apply to the *building*, if— (a) either— (i) the use of artificial lighting in the *building* could adversely affect the behaviour or welfare of animals kept in the *building*; or (ii) the *building* is a *vehicle storage farm building* that is not an *open-walled building*; and (b) the *building* provides non-illuminated exit signs that comply with of AS 2293.1:2005, section 6 – Design of Exit Signs Installation, clauses 6.2, 6.5, 6.6, 6.8 and 6.9.

PERFORMANCE REQUIREMENT		ACCEPTABLE SOLUTIONS

Artificial lighting

P8 The requirements that must be satisfied, for a *building* to which this performance requirement applies, are those in the *BCA*, volume 1, FP4.2.

Note—

P8 applies to particular *low occupancy farm buildings*. (See section 4.)

A8 (1) The variation mentioned in subsection (2) applies for the *building*.

(2) The *BCA*, volume 1 is varied so the *BCA*, volume, F4.4 does not apply to the *building*, if—

(a) the use of artificial lighting in the *building* could adversely affect the behaviour or welfare of animals kept in the *building*; or

(b) natural light that enters the *building* provides the level of *illuminance* required by FP4.2.

Requirements for vehicle storage farm buildings

P9 A *building* to which this performance requirement applies must be designed and constructed so it complies with —

(a) the *BCA*, volume 1, part D3 stated for a *class* 7(a) *building*; and

(b) the *BCA*, volume 2, section 2 (Performance provisions); and

(c) the following—

(i) the requirements mentioned in P2;

(ii) the requirements mentioned in P4(b);

(iii) the requirements mentioned in P5 and P7.

A9 (1) The *building* must comply with subsection (2) or (3).

(2) The *building* complies with this subsection if it—

(a) is an *open-walled building*; and

(b) complies with the deemed-to-satisfy provisions in—

(i) the *BCA*, volume 1, part D3 stated for a *class* 7(a) *building*; and

(ii) the *BCA,* volume 2, stated for a *class* 10a *building*, as though it were a *class* 10a *building*.

(3) The *building* complies with this subsection if it—

(a) is not an *open-walled building*; and

PERFORMANCE REQUIREMENT	ACCEPTABLE SOLUTIONS
Notes— 1 P9 applies to particular *vehicle storage farm buildings*. 2 P9 is intended to allow a *class* 7a *building* that is a *vehicle storage farm building* to be constructed to the requirements for a *class* 10a *building* to a limited extent.	(b) complies with— (i) the deemed-to-satisfy provisions in the *BCA*, volume 1, part D3 stated for a *class* 7(a) *building*; and (ii) the deemed-to-satisfy provisions in the *BCA*, volume 2, stated for a *class* 10a *building*, as though it were a *class* 10a *building*; and (iii) the deemed-to-satisfy provisions in the *BCA*, volume 1 relevant to P2, varied as mentioned in A2(2); and (iv) the deemed-to-satisfy provisions in the *BCA*, volume 1 relevant to P4, for fire extinguishers, varied as mentioned in A4; and (v) the requirements in A5 and A7(2)(b).