

# Civil Engineering Technical Requirement

## CIVIL-SR-005

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# DESIGN OF BUILDINGS OVER OR NEAR RAILWAYS

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Revision: D

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## 1.0 INTRODUCTION

This Technical Requirement details the criteria which must be met by external party designs for buildings over or within 25 m of railway property. Reference is made to the following additional Queensland Rail Technical Requirements which must also be satisfied:

- CIVIL-SR-002 *Work in or about Queensland Rail property,*
- CIVIL-SR-003 *Work adjacent to overhead line equipment,*
- CIVIL-SR-007 *Design and selection criteria for road / rail interface barriers,*
- CIVIL-SR-008 *Protection screens,*
- CIVIL-SR-012 *Collision protection of supporting elements adjacent to railways, and*
- CIVIL-SR-014 *Design of noise barriers adjacent to railways.*

Copies of these documents may be obtained from Queensland Rail.

All reference documents, e.g. Australian Standards, codes and Queensland Rail Technical Requirements, are to be the latest version.

## 2.0 SCOPE

This Technical Requirement applies to the:

- design of new buildings, and
- upgrading of existing buildings.

It covers the design criteria for buildings which are neighbouring Queensland Rail property (with a common boundary), as well as buildings which are above and enclose the railway tracks. Only those matters which will affect or are affected by the presence of the railway are covered. For example, the aesthetics or internal use and features of the building are not considered.

The presence of buildings over or near high speed or heavy haul railway lines is highly undesirable on safety grounds associated with increased consequence from derailment and will be limited by Queensland Rail.

## 3.0 DESIGN AND DOCUMENTATION

### 3.1 General

The design of buildings over or near the railway is to comply with:

- 
- Building Code of Australia,
- relevant Australian Standards,
- AS 5100 *Bridge Design* for collision protection and collision loads, and
- this Technical Requirement and associated Technical Requirements.

Designers are to liaise with Queensland Rail to minimise the effect of construction on train services and to determine whether Queensland Rail will accommodate any speed restrictions, track closures and/or isolations of the overhead line equipment (OHLE) anticipated during construction.

The design of the building is to take into account the available access to the building site and the need to minimise interference with train operations, passengers and railway activities during construction.

Queensland Rail reserves the right to restrict construction methods to those that minimise interference to train operations, passengers and railway activities.

Existing access to Queensland Rail property for maintenance and emergency is to be maintained at all times during construction work.

All documentation for the construction of buildings is to allow for and include:

- CIVIL-SR-002 *Work in or about Queensland Rail property, and*
- CIVIL-SR-003 *Work adjacent to overhead line equipment (where applicable)*
- CIVIL-SR-007 *Design and selection criteria for road / rail interface barriers,*
- CIVIL-SR-008 *Protection screens,*
- CIVIL-SR-012 *Collision protection of supporting elements adjacent to railways, and*
- CIVIL-SR-014 *Design of noise barriers adjacent to railways..*

The drawings are to show:

- design loads,
- any special provisions, e.g. structural redundancy and use of precast or prefabricated elements
- railway centrelines in the vicinity of the proposed building,
- clearances from building to track and OHLE,
- railway kilometrage linked to the set out, and
- details of all existing railway infrastructure, including maintenance and emergency access under and in the vicinity of the proposed building.

All structural drawings, including temporary works such as falsework and formwork shall be certified as having been designed in compliance with the Professional Engineers Act.

Prior to construction, copies of the drawings and documentation consisting of:

- overall scope of construction works,
- demolition scheme,
- collision protection measures,

- assessment of risks from dangerous goods transport with appropriate control measures in the design, and
  - details of work within / over / adjacent to Queensland Rail property,
- are to be submitted to Queensland Rail for review and a compliance check against Queensland Rail's Technical Requirements and Standards.

Construction is not to commence until permission has been received from Queensland Rail.

### 3.2 Clearances

Clearances to railway tracks are to satisfy the minimum requirements of the following, unless otherwise approved by Queensland Rail:

- Queensland Rail Standard Drawing No 2754
- trackside access roads,
- formation drainage,
- sighting requirements for railway signals and level crossings,
- special items of overhead traction wiring equipment, e.g. switches, transformers, wiring at turnouts,
- passenger platform requirements, and
- access to clean and maintain the building.

For buildings across existing and future electrified lines, the building's support structure is to be located clear of the overhead wiring system and to have protection screens installed in accordance with Queensland Rail Technical Requirement CIVIL-SR-008 *Protection screens*.

The drawings of the proposed building are to show the railway clearance outline superimposed on an elevation of the building at 90° to the track alignment.

### 3.3 Earthquake Protection

Buildings over or near railways are to be classified as "importance level 2 structures" for the purposes of AS 1170.4 *Structural design actions: Part 4 Earthquake actions in Australia*.

Buildings are to be designed to minimise the risk of collapse during earthquakes, with particular attention being given to:

- bearing arrangements,
- widths of bearing shelves, and
- reinforcing steel in columns.

### 3.4 Durability

The design life of the building over or adjacent to the railway tracks needs to be a minimum of 100 years.

Buildings are to be designed so that maintenance will have no effect on Queensland Rail's operations. No access from the railway corridor is allowed.

### 3.5 Lighting and Ventilation

A building enclosing the railway is to be designed to maximise natural air flow and lighting within the

railway corridor. Where a building abuts the railway corridor, it is not to produce lighting or ventilation shafts within or opening onto the railway corridor. Where it is determined that artificial light and mechanical ventilation of the railway corridor is required, the building owner or its agent is to provide and maintain:

- independent power supply for these services, and
- back-up plant and power supply to ensure continuous light and ventilation in case of failures and emergencies.

### 3.6 Demolition

A building is to be designed so that it can be demolished progressively without causing interference to train operations, passengers and any railway activities. A demolition scheme is to be included in the drawings and documentation to be submitted to Queensland Rail as required by Section 3.1.

## 4.0 SUBSTRUCTURE - FOUNDATIONS

Foundations are to be designed to be installed with minimum interference to railway operations.

No excavation within or under the railway corridor is permitted, unless agreed to by Queensland Rail. Permanent soil nails / rock anchors are not permitted to extend into the railway corridor. Temporary soil nails / rock anchors may be permitted during construction of the substructure. They must be designed not to interfere with railway infrastructure. On completion of each level of the substructure, the temporary soil nails / rock anchors for that level are to be de-stressed, as agreed by Queensland Rail.

The period from commencement of excavation until completion of the substructure to at least rail level adjacent to the railway must not be more than 6 months.

The design of shoring systems for excavations adjacent to operating railway tracks is to be submitted to Queensland Rail for review before construction commences.

Foundations are not to interfere with corridor drainage. Provision is to be made for railway formation drainage. Drains are to be lined where appropriate and are to be clear of the track. Piers and foundations are to be designed to allow free drainage along the formation and are not to cause ponding. For deep excavations next to the corridor, the design of the retaining structures is to include provision for drainage.

## 5.0 PIERS – COLLISION PROTECTION

### 5.1 General

Buildings are to be a single clear span over existing and future railway tracks, unless agreed otherwise by Queensland Rail.

Collision protection and collision loads are to be in accordance with AS 5100 *Bridge Design* and Queensland Rail Technical Requirement CIVIL-SR-012.

### 5.2 Upgrading of Existing Buildings

Existing piers and columns which do not satisfy the requirements in Section 5.1 are to have deflection walls provided. Independent deflection walls are to be provided where space permits. For details refer to Queensland Rail Technical Requirement CIVIL-SR-012.

### 5.3 Design Report

A design report on the measures adopted for collision protection is to be included in the drawings and documentation to be submitted to Queensland Rail as required by Section 3.1.

## 6.0 SUPERSTRUCTURE

### 6.1 General

Building superstructures over existing tracks are to be designed to minimise the time needed for erection, e.g. precast / prefabricated components. The aim is to minimise any delays to train services during construction from speed restrictions, track closures and / or isolations of the overhead traction wiring equipment.

The connection between the deck and piers is to be designed to minimise the risk of collapse in the event of an earthquake or collision from railway traffic.

### 6.2 Building Drainage

Building drainage is to discharge in a manner which does not adversely affect railway tracks, associated railway facilities or property occupied by Queensland Rail. Building drainage discharge via scuppers is not permitted from spans over existing and future railway tracks. Building drainage pipes are to comply with the requirements for services in Section 9.

## 7.0 TRAFFIC BARRIERS

In areas of the building accessible by vehicles, traffic barriers are to be provided across the railway corridors to prevent vehicles from accessing Queensland Rail tracks and property.

Traffic barriers are to be designed in accordance with AS 5100 *Bridge Design* and Queensland Rail Technical Requirement CIVIL-SR-007. Building designers are to reach agreement with Queensland Rail on the barrier performance level.

## 8.0 PROTECTION SCREENS

Protection screens are to be designed to protect the railway by preventing:

- public access to overhead traction wiring equipment and the track, and / or
- the throwing of objects at trains, stations and staff / public on the railway corridor.

The minimum requirements for protection screens are provided in Queensland Rail Technical Requirement CIVIL-SR-008.

## 9.0 SERVICES

Buildings are not to disturb existing Queensland Rail services (signal, telecommunications and OHLE) and other externally-owned services. Existing underground services that are to remain in

place are to be protected from loads during construction and operation of the building. Design details are to be submitted to Queensland Rail for review.

The building's services, including pipes for deck drainage, are not to be attached to the sides or undersides of buildings over or adjacent to the railway.

Services and their attachment to the building are to have a 100 year design life and are to be designed for replacement without effecting Queensland Rail operations. Design and material selection is to be subject to review by Queensland Rail. Drainage systems are to be designed to prevent leakage onto the railway corridor.

## 10.0 WATERPROOFING

Building enclosures over railways are to be waterproofed to prevent water leaking through to the railway.

## 11.0 ANTI-GRAFFITI COATING

Any parts of the building vulnerable to graffiti and visible from trains and railway platforms are to be protected by an approved non-sacrificial coating.

## 12.0 ADVERTISING SIGNS

Advertising signs and other hoardings are not to be placed on buildings over or having a common boundary with the railway, unless approved by Queensland Rail.

If existing advertising signs on Queensland Rail property will require removal or relocation because of the proposed works, Queensland Rail must be advised as early as possible. Failure to do so may cause delays to the start of work. All costs



associated with the removal and relocation of these signs are to be borne by the owner of the building.

### 13.0 TRANSPORT OF DANGEROUS GOODS

#### 13.1 Background

The railway tracks under or beside the building may be used for transporting various dangerous goods (DG) and the effects of this are to be considered in the design of the building.

The feasibility of the development of buildings over the railway could be influenced by the cost of the risk control measures.

This section provides information about some of the hazards and some control measures that may be adopted for a building.

It is the responsibility of the building's owner or its agent to:

- assess the information,
- consider all aspects relating to the consequences of a dangerous goods accident,
- determine the appropriate control measures to be used in each particular case, and
- incorporate control features into the building to minimise negative impacts on the railway.

The potential risks from the escape of DG from their containment as the result of a railway accident, are fires, explosions and toxic emissions, either directly from chemical spills or as products of combustion / reactions.

The designer of the building is to consider the following aspects of the risks posed by transporting DG:

- safety of people occupying the building,
- safety of people on platforms or in trains under or near the building,
- structural damage to the building and / or adjacent structures,
- business interruptions and financial loss to building occupants in the event of incidents affecting the building,
- commercial risks to Queensland Rail in the potential loss of freight and passenger business in the event of incidents,
- increasing risks as a result of transporting DG by train through areas of increasing population and infrastructure density, and
- adverse public perceptions of the dangers of transporting DG through enclosed platforms, especially security related issues.

The following control measures have been identified by quantitative risk assessment and are to be considered in the design of the building:

- minimise or control the outbreak of fire,
- control the smoke / gas release from a fire,
- minimise the heat build-up in structures,

- limit the blast damage to structural components,
- provide stability or contingency measures to the design of the building, and
- provide safe emergency access and egress from the railway track area and the building.

The control measures identified are generic and all of them may not apply to all buildings. The extent of their applicability will need to be determined for each building, depending on its location and type.

In all cases where a building encloses the railway, provision is to be made in the design for access to the railway corridor so that cleaning of the railway infrastructure (station facilities, track, ballast, cess drains, etc.) can be performed after a DG incident.

For the purposes of a building which encloses railway tracks on both sides and above for a greater length than 80 m, the situation regarding limited ventilation is to be considered as similar to a tunnel.

Documentation is to be submitted to Queensland Rail for review, in accordance with Clause 3.1, and is to include a specialist design report on the assessment of DG risks and the control measures adopted in the design. Buildings that have a sufficiently wide enclosure over the tracks may or may not behave like a tunnel depending on the length to width ratio of the enclosure. Such cases have to be considered by computational modelling of smoke generation by fires to determine an effective ventilation strategy.

#### 13.2 Design Intent

The aim of the design of buildings is to maintain structural integrity and so enable:

- people to escape from the building to a safe area,
- people to be rescued from stations beneath the building and evacuated to a safe area, and
- emergency services to control the fire before significant structural damage can occur.

Any building over or beside the railway must be able to withstand a fire, explosion, chemical spill, liquid fuel spill, gas emission, etc. resulting from a derailment or other incident and still provide protection for users of the building.

#### 13.3 Design Measures for the Control of Fire

This information is provided for the consideration of the building's designer for inclusion in the design.

One way to reduce the rate of temperature rise in a fire within an enclosure is to provide adequate ventilation. Ventilation reduces the build up of smoke and toxic gases in the enclosure, and heat affecting the structure above. Ventilation can be fed in a direction that creates a clear air entry for emergency response personnel. Alternatively,

smoke and gases can be drawn into a ventilation duct and taken away from the enclosure space, so keeping the air in the enclosure free of smoke and gas, and achieving the design intent in Section 13.2. Mechanical ventilation for fire and life safety is mandatory when the enclosure contains platforms or station facilities.

Some design measures are outlined below:

1. Keep the length of the enclosure above and around the tracks to less than 80 m wherever possible, so that the onerous provisions of a tunnel may not be required. It also minimises hot gas layer build-up and heating of the building.
2. Provide sufficient gaps between buildings to ensure ventilation can occur between enclosures. Provide off-takes at the portals for ventilation. The optimum length for gaps (between buildings) is best determined by a generic ventilation study of an enclosed track section, using various lengths of enclosed track.
3. If the enclosure is longer than 80 m, making it a tunnel, consider providing a natural ventilation shaft at appropriate intervals. Where the enclosed section is also wide, the requirements shall be determined by smoke modelling.
4. The discharge point of the vent requires careful consideration as there is potential for dispersion of toxic plume (from the discharge point) to enter the air-conditioning air intake duct of the building. Dispersion modelling needs to be carried out using the meteorological data applicable to the building location, for various combinations of wind speeds and Pasquill stability conditions.
5. Construction of ventilation shafts to the "surface" may require consideration of formal permissions or tenure rights for a ventilation outlet to exist if outside Queensland Rail property. Consideration needs to be given to Queensland Rail's long-term rights for the vent structure to remain and operate unrestricted while the railway operates.
6. Undertake modelling of smoke dispersion at the concept design stage to predict ventilation patterns. Computational models provide a useful tool in this area.
7. The enclosure structure itself shall be designed for a fire load of 60 MW. This may be achieved by one or more of the following:
  - (a) selecting an appropriate thickness for the enclosure soffit,
  - (b) coating the enclosure soffit with passive fire protection material, and
  - (c) providing sprinklers on the enclosure soffit above the tracks to reduce the heat generation rate and suppress fire by preventing air flow to the fuel.
8. Option (c) will not be permitted if it interferes with the overhead traction equipment. Further, the situation would be aggravated if water is sprayed on Class 4.3 goods or burning xanthates. The frequency of transport of xanthates and Class 4.3 goods may be significantly lower than that for flammable liquids such as gasoline.
8. The effect of more fuel will not increase the temperature of a hydrocarbon fire, but will only extend the duration of the fire. Therefore, the temperatures attained will be similar to those used in the design of road tunnels and the international code developed by PIARC will be appropriate.
9. Smoke dispersion modelling is to be used to predict the location of the smoke plume relative to the building. The building's air-conditioning air intakes are to be located clear of these areas. However, the air intakes are to be fitted with smoke detectors which will automatically shut down the air-conditioning fan and damper.
10. Ventilation design needs to cater for operation during a fire emergency. The ventilation system must be able to control smoke and allow emergency response teams to enter the enclosed space safely with appropriate fire fighting and protective equipment.
11. Provision for the capture of large spills of flammable liquid.
12. The provision of fire detection and alarms in the enclosure.
13. Protection of fire detection equipment from the fire itself. Separate circuits with feeds from both ends of the enclosure and closed loops are essential to ensure that these communications remain open during a fire.
14. Provide adequate water drainage from the enclosed section of track, to avoid causing a hazard to fire fighters from burning fuel floating on the water.
15. Including emergency exit doors leading to escape passages to enable a mass evacuation of a passenger train, should a freight train carrying DG be stopped in the enclosure because of a fire or explosion.

#### 13.4 Design Measures for Passive Fire Protection

This information is provided for the consideration of the building's designer for inclusion in the design.

Spalling of concrete can be limited and structural integrity can be maintained by the use of passive fire protection (PFP) materials. These coatings reduce the build-up of heat on the concrete surface and therefore limit the potential for spalling.



A PFP material is defined as, “a coating, cladding or free-standing system which, in the event of a fire, will provide thermal protection to restrict the rate at which heat is transmitted to the object or area being protected”. These materials are used to:

- prevent escalation of the fire due to progressive releases of inventory, by separating the different fire risk areas, and hence protect personnel until safe evacuation can take place,
- protect essential safety items and critical components such as separators, risers and topside emergency shutdown valves, and
- minimise damage to the building by protecting the critical structural members.

The use of passive fire coatings has been shown to maintain concrete surface temperatures in hydrocarbon fires below 400°C for up to 2 hours.

The use of polyfibres in concrete and minimising moisture content has also been shown to limit spalling. The polyfibres melt, providing space for moisture to expand.

Some design measures are outlined below:

1. Consider use of Passive Fire Protection materials to coat the soffit of the enclosure, as an alternative to structural design alone for a significant hydrocarbon fire.
2. Ensure that all materials to be used in the construction of the enclosure are evaluated with regard to their flammability and combustion characteristics.
3. Develop a building evacuation plan in the event of a fire in the enclosure.
4. Nominate a safe assembly area for the building occupants in the building evacuation plan.

### 13.5 Design Measures for the Control of Blast Damage

This information is provided for the consideration of the building’s designer for inclusion in the design.

The collision loads in AS 5100 do not cover the impact of explosions in enclosed spaces underneath a building.

Some design measures are outlined below:

1. In addition to looking at the actual structural design of specific support elements, limiting the effects of blast damage in a building may include:
  - (a) selective location of support pillars to avoid domino effects,
  - (b) spacing of pillars of sufficient number to provide strength, but at the same time providing adequate ventilation,
  - (c) use of structural walls instead of pillars only in cases where pillars are insufficient to support the load, and

- (d) provision of additional support elements
2. A structural redundancy analysis shall be carried out to verify the capacity to support the deck load at the ultimate limit state with one or more of the supporting columns removed.
3. Consider providing alternative support structures for the building independent of the enclosure, additional fire rating etc, so that the integrity of these structures can be maintained. The need for this has to be determined on a case by case basis.
4. Configuration of a ventilation system which allows rapid ventilation transition to zero air movement may be useful in a range of scenarios.

## 14.0 CERTIFICATION OF DESIGN AND CONSTRUCTION

The building design is to be carried out in compliance with the Professional Engineers Act. The designer is to specify the functional requirements and the standards used for the design.

Design is to include verification by competent engineers not directly involved in the design that the design complies with the specified functional requirements and related standards.

The designer is to provide formal certification to Queensland Rail that the building design and verification requirements have been met. The certification is to include a summary of the specified functional requirements and related standards.

The completed building must be certified by a Registered Professional Engineer of Queensland as having been constructed in accordance with the drawings and any approved variations.

## 15.0 AS CONSTRUCTED DRAWINGS

Within six (6) weeks of practical completion of construction, the constructing authority is to provide Queensland Rail with:

- as constructed drawings (plan and section) for the building, showing the relationship to the railway tracks and all adjacent railway infrastructure,
- collision protection elements for the building, and
- DG risk mitigation measures.

Drawings are to be in electronic pdf format.

**16.0 ASSOCIATED COSTS INCURRED  
BY QUEENSLAND RAIL**

All of Queensland Rail's costs associated with the review, design and construction of the building and the implementation of Queensland Rail's Technical Requirements will be charged to the building owner or its agent. This includes any remedial work necessary to Queensland Rail property as the result of this work and any accidental damage, as well as costs associated with train delays. Rates will be set by Queensland Rail.