Chapter D2 – Thiess Intersection Design Fundamentals (EMESRT 1)

CONTEXT

Intersection Design Fundamentals is a core training program that supports and reinforces Thiess' processes for managing mine traffic across its global operations.

RESULTS

The outcome of this program is to provide a deeper understanding of key intersection design principles.

APPROACH

This program was designed to provide an understanding of why key principles are fundamental, and how these are related to the physiology of human information perception in conjunction with applicable collision theorems.

DISCUSSION

By providing an understanding of the 'why' to front-line management staff, implementation and proactive maintenance of intersection design standards is improved.

ALIGNMENT WITH NEW CONTROL MANAGEMENT THINKING

One of the primary controls for preventing a collision at an intersection is the quality of the decision that a driver makes when proceeding into that intersection. This is a human act. Intersection design principles are key in supporting decisions which inform acts.

ALIGNMENT WITH EMESRT MODEL

The work involved developing and applying a process that baselined a multiple-site business approach aligned with levels 1-3.

CONTRIBUTORS

The project team included Thiess operations and safety teams along with public road safety experts.

CHAPTER D2
THIESS INTERSECTION DESIGN FUNDAMENTALS

FEBRUARY 2017

CHAPTER OVERVIEW

Context
Intersection Design Fundamentals is a core training program that supports and reinforces Thiess' processes for managing mine traffic across its global operations.

Results
The outcome of this program is to provide a deeper understanding of key intersection design principles.

CHAPTER OVERVIEW

Approach

This program was designed to provide an understanding of why key principles are fundamental, and how these are related to the physiology of human information perception in conjunction with applicable collision theorems.

Discussion

By providing an understanding of the 'why' to front-line management staff, implementation and proactive maintenance of intersection design standards is improved.

CHAPTER OVERVIEW

Alignment with new control management thinking

One of the primary controls for preventing a collision at an intersection is the quality of the decision that a driver makes when proceeding into that intersection. This is a human act. Intersection design principles are key in supporting decisions which inform acts.

Alignment with EMESRT Model

The work involved developing and applying a process that baselined a multiple-site business approach aligned with levels 1-3.

Contributors

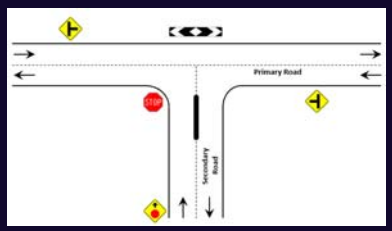
The project team included Thiess operations and safety teams along with public road safety experts.

THIESS DISCLAIMER – EVERY SITE IS DIFFERENT

- At every site the optimum traffic intersection design is different
- Thiess has developed this presentation to assist in the implementation of best practice intersection design, to:
  - minimise the risk of harm to our people; and
  - maximise the efficiency of operations.
- Please make your own enquiries and challenge your existing design using your own professional advisers - you should not rely on this presentation

INTERSECTION COLLISION – PREVENTATIVE CONTROLS

- Picture a typical mine intersection in your mind….
- What are the controls that prevent a collision at that intersection?



Stop signs, speed limits, other signage, sight distances, centre bunds, orientation, etc.

Are they really controls?

1. Elimination of Vehicles and
2. The decision a driver makes whether to proceed into the intersection or not – **A human act**.

HOW OUR EYES WORK AND HOW WE ARE WIRED

- Consider your experience driving on public roads. Have you ever experienced a situation where a car or a bike just seemed to come out of nowhere?
- What is the problem, vision impaired?
- Well, yes for small but significant period of time you are not able to see anything at all
- This is generally not a problem for us, but if another vehicle is about to occupy the same space as you, this is not good.
- Evolution - we have evolved as predators. Our eyes and the way our brains process images are well suited to creeping up on prey and monitoring movement in our periphery
  - Only a small part of our retina, in the centre called the fovea, an generate a high resolution image – focus test
  - The rest of the retina contributes by adding peripheral detail

THIESS

HOW OUR EYES WORK AND HOW WE ARE WIRED

- How we build an image in our brain:
- Saccades and fixations, think of a camera being moved as you take a photo – mirror test
- Our brains fill in the gaps with a combination of peripheral vison and an assumption that what is in the gaps is the same as what is seen during the pauses
- Our brain and eyes prioritise what to focus on and move fast to generate a high resolution image
- Without the saccade/fixation mechanism our brains would be overloaded with unnecessary detail and blurred images.
- There are times that we don't see anything at all, and what we see may not be what is actually there
- It does get worse:
  - Peripheral vision is very good at detecting movement
  - Vehicles travelling at a constant speed will stay in the same position relative to each other as they approach a point of collision – i.e. no detectable movement in the windscreen.

THIESS

HOW OUR EYES WORK AND HOW WE ARE WIRED

And even worse

- There is the phenomenon of 'expectation' and your brain is less likely to recognise something that you are not expecting to see.
- This means that if you think the road is empty, you are less likely to register that a vehicle is actually present
  - Situational blindness – looked but failed to see i.e. what you're not 'expecting' to see.

And even worse still…

- We cannot see through solid objects, but we also struggle to look or focus near the edges of a framed scene
- That is, we tend not to look near the edges of a windscreen, this is known as 'windscreen zoning'
- Not only do pillars form a physical blind spot, but our eyes tend not to fixate near to them
- The equipment visibility diagrams we typically utilise are actually worse than depicted.

APPLICATION OF THIS KNOWLEDGE

- Although this sounds like we shouldn't be able to get out of bed without running into things, it is not all doom and gloom
- An understanding of how we see and process images along with the primary preventative control at an intersection being the human act of whether to proceed into an intersection or not are fundamental considerations and elements of the intersection design process
- Fundamentally, everything we need to do is to enable a driver to make the best and right decision at an intersection.

OK, SO WHAT MAKE A GOOD INTERSECTION?

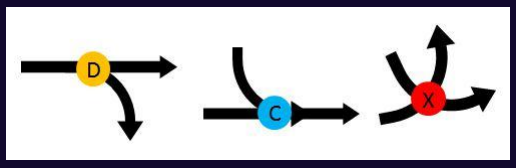
- Simplicity
- Situational awareness
  - Awareness of the intersection
  - Easy interpretation of traffic flow on approach
- Good sight distance
  - On approach to the intersection
  - Throughout the intersection
- Good geometry / layout
  - Intersecting roads at 90° (+/- 5°)
  - Minimisation of conflict points
- Clear traffic flow
  - Clear and concise direction provided
  - Clear articulation of right of way requirements
  - Appropriate traffic "channelling" on secondary roads
  - Consistent with public road rules.

HOW DO WE ACHIEVE THIS?

- Understanding that the primary preventative control at an intersection is the human act of whether to proceed into an intersection or not
- Effective intersection design processes:
  - Conflict point analysis
  - Sight distance analysis
- Appropriate orientation and treatments
- Effective intersection traffic control measures
- Effective change management processes
- Effective maintenance to the original intersection design parameters.

CONFLICT POINT ANALYSIS

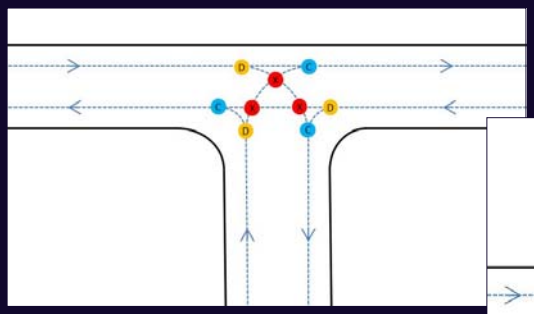
- Conflict points are locations where possible collisions may occur between vehicles
- Three types of conflict points are important for intersection analysis (diverging conflict point, converging conflict point, and a crossing conflict point)



- Conflict point analysis aims:
  - Ensure the total number of conflict points is kept to a minimum
  - Ensure conflict point frequency is minimised
  - Reduce the complexity of a drivers' decision process by introducing appropriate controls at conflict points specifically for driver judgments of clearance time and distance to potentially conflicting traffic.

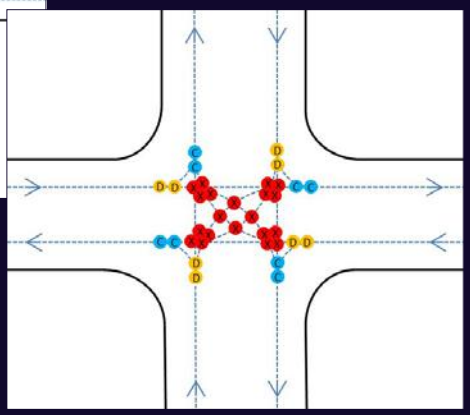
THIESS

CONFLICT POINT ANALYSIS



T' Intersection
9 Conflict Points

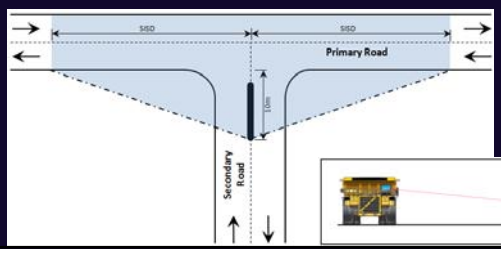
Cross' Intersection
32 Conflict Points



THIESS

SIGHT DISTANCE

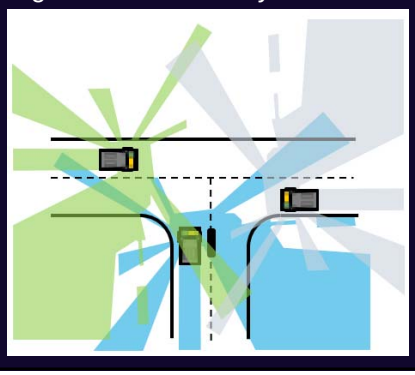
- Ensure intersections are positioned and designed to maximise sight distance on approach and throughout the intersection
- Give consideration to sight distance in both the horizontal and vertical planes
- A sight distance envelope of 10m on the secondary road
- approach and the required Safe Intersection Sight Distance
- (SISD) either way along the primary road is desirable.



Speed (km/hr)	Safe Intersection Sight Distance (SISD)
10	10 m
20	30 m
30	50 m
40	70 m
50	90 m
60	110 m
70	145 m
80	185 m

SIGHT DISTANCE

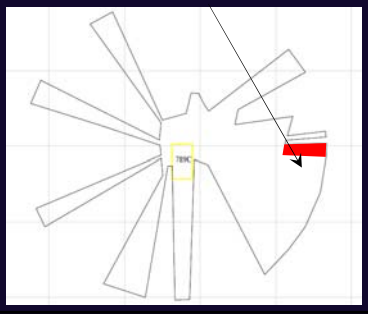
- Where required utilise scaled equipment visibility diagrams to assist in the design process
- Model vehicle movements along all identified travel paths with these diagrams to identify potential sight distance and visibility issues
  - o Remember visibility diagrams are actually worse than depicted (windscreen zoning).



SIGHT DISTANCE

- Give consideration to retro-fitted accessories e.g. fire suppression tanks, access systems etc. on mobile equipment when considering equipment visibility diagrams and sight distance
- If possible, move poorly positioned accessories to increase visibility.

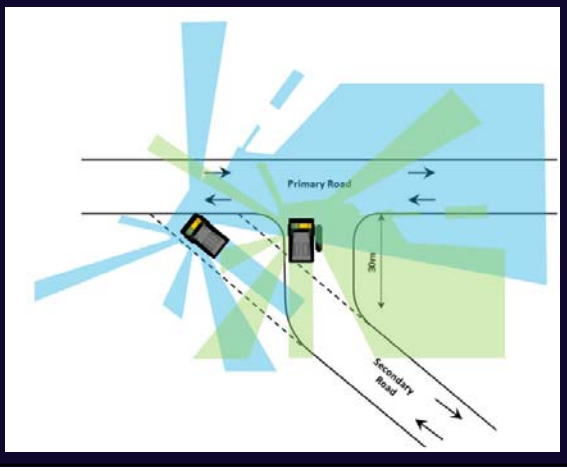
Visibility restriction associated with poorly positioned fire suppression tanks



THIESS

GEOMETRY AND TREATMENTS

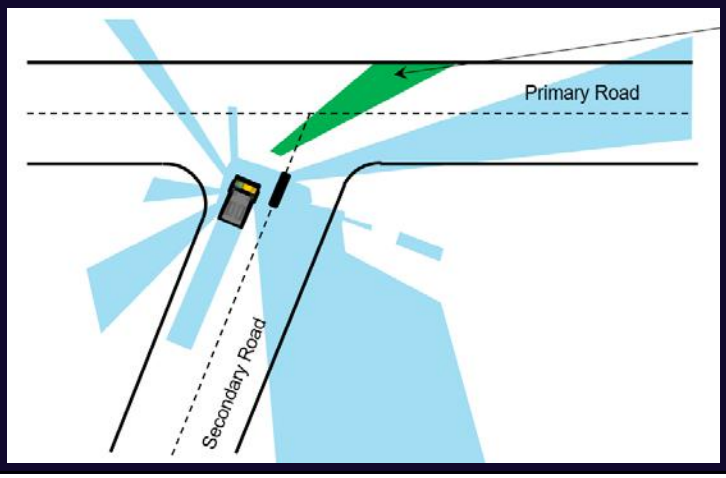
- Ensure roads intersect at 90° (square) to each other
- Common 'Y' intersections treatment.



THIESS

GEOMETRY AND TREATMENTS

- 'Y' intersections orientated in this direction result in a 'false' perception of improved visibility.

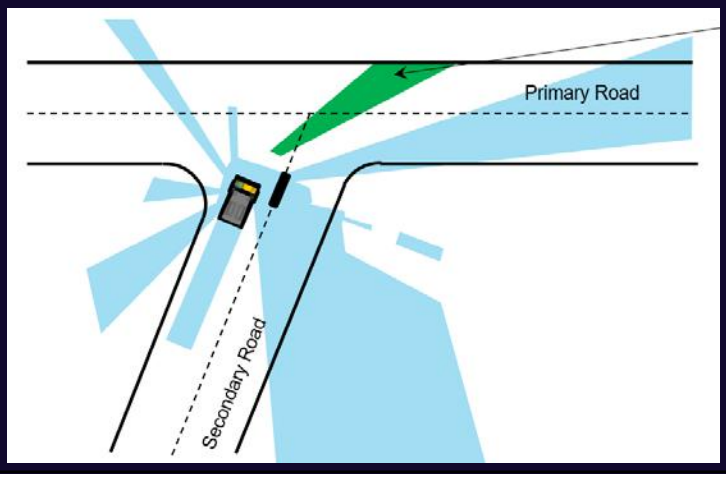


This represents the blind spot from the 'A' pillar for a truck positioned at 90°

Improved visibility with open 'Y' intersections is typically a MYTH

GEOMETRY AND TREATMENTS

- 'Y' intersections orientated in this direction result in a 'false' perception of improved visibility.

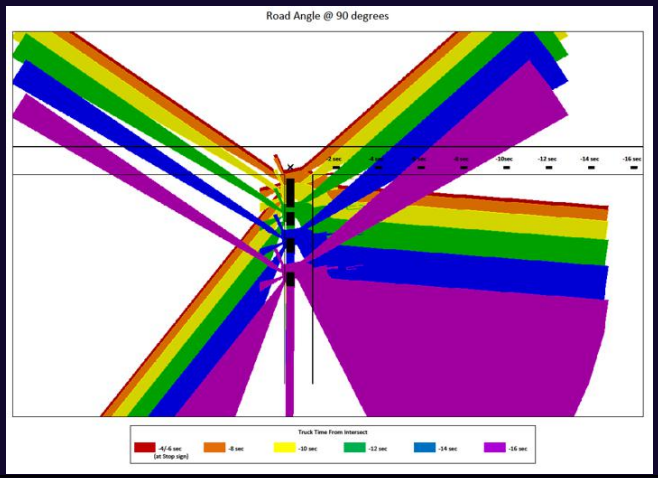


This represents the blind spot from the 'A' pillar for a truck positioned at 90°

Improved visibility with open 'Y' intersections is typically a MYTH

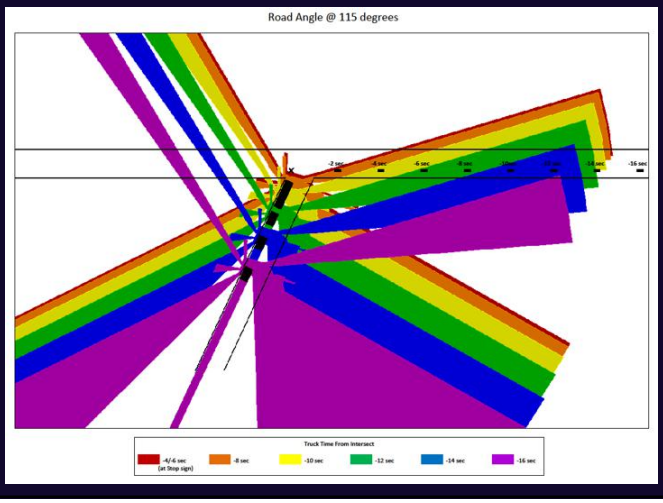
GEOMETRY AND TREATMENTS

- This details a truck constantly decelerating to a stop sign at a 90° and a LV travelling at 60km/hr on approach to an intersection and associated visibility restrictions.



GEOMETRY AND TREATMENTS – SYMMETRY OF COLLISION

- For an open 'Y' intersection at 115°, the LV remains in the 'A' pillar blind spot for the entire time as both vehicles approach a collision at the 0 sec mark.

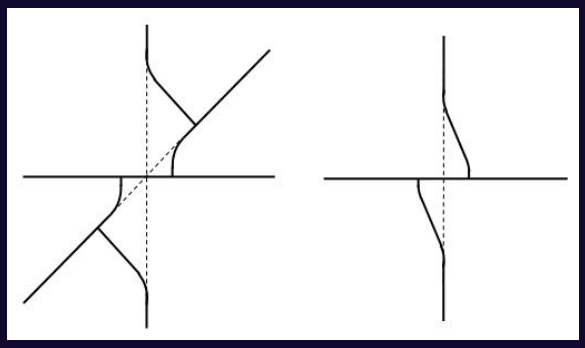


GEOMETRY AND TREATMENTS

- This represents the view form an operators perspective stopped at a stop sign of an intersection orientated at 115°.

GEOMETRY AND TREATMENTS

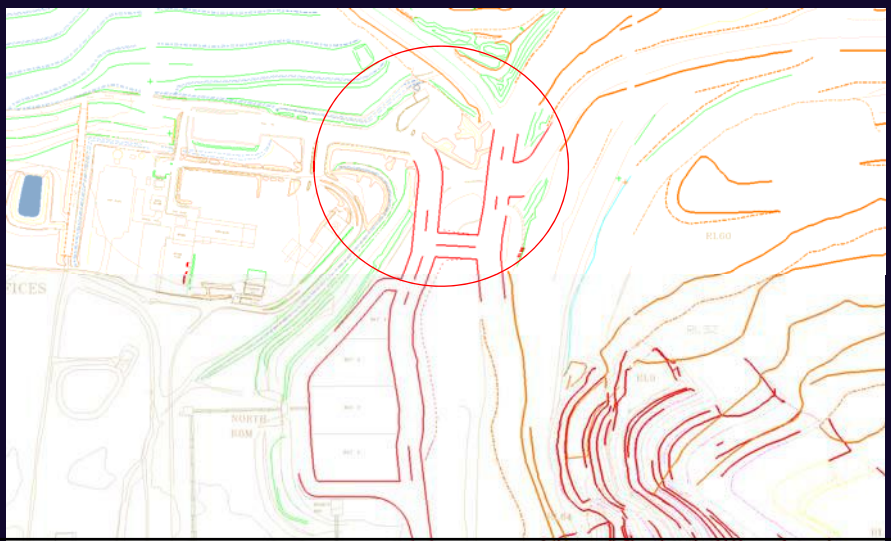
- Common treatments for multi-leg intersections (Staggered 'T's)
- Ensure intersections within close proximity to each other are appropriately separated by an offset (70m CL to CL).



79 Conflict points reduced to 36 conflict points (4 separate intersections with 9 conflict points each)

32 Conflict points reduced to 18 conflict points (2 separate intersections with 9 conflict points each)

GEOMETRY AND TREATMENTS – INDUSTRY CASE STUDY



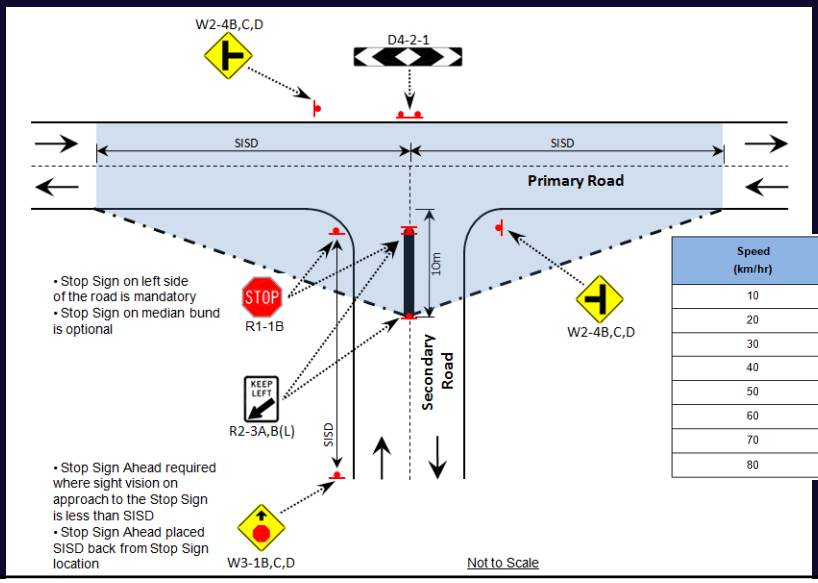
TRAFFIC CONTROL

- Ensure appropriate traffic controls are provided to enable the safe and efficient movement of vehicles through an intersection
- Consider traffic volumes and loaded haulage routes when determining traffic flow priority
- Appropriately positioned and sized median bundwalls should be used to provide traffic separation within an intersection
- Ensure that median bundwalls are positioned to appropriately 'channel' vehicles into the required orientation i.e. square on the secondary road approach
- Adequate signage shall be installed to provide warning on approach to an intersection and to provide clear direction within the intersection.

TRAFFIC CONTROL

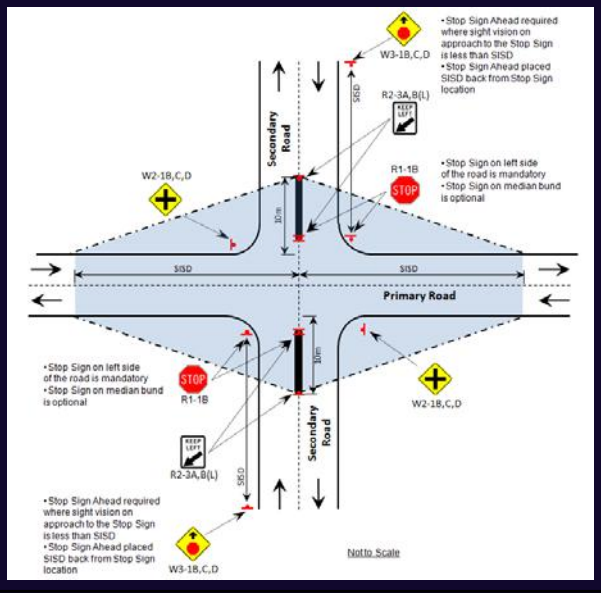
- Stop signs shall be utilised to control right of way obligations on all haul roads
- Utilise speed restriction signage where intersection sight distance requirements are substandard and/or at more complex intersections e.g. greater than 9 conflict points etc.
- Ensure traffic management controls are consistent with public road rules.

TRAFFIC CONTROL – INTERSECTION SIGNS



Speed (km/hr)	Safe Intersection Sight Distance (SISD)
10	10 m
20	30 m
30	50 m
40	70 m
50	90 m
60	110 m
70	145 m
80	185 m

TRAFFIC CONTROL – INTERSECTION SIGNS



CHANGE MANAGEMENT

- Ensure effective change management processes are followed
- Refer to site change management procedure
- Ensure that intersections are maintained to preserve the intersection design parameters.