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SAFETY NEWS

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[2] LTA 4th CORPORATE SAFETY RETREAT

BACKGROUND

Since 2007, LTA has held its safety retreats with the primary objective of creating a forum for LTA's Senior Management and key Project Management staff to review LTA's safety performance, set safety targets and establish new initiatives aimed at achieving Zero Accident within LTA worksites.

Over the years LTA has been placing significant resources and efforts in its enhancement of construction safety through the improving of knowledge sharing, safety specifications, enforcement and the implementation of initiatives. This culminated in the launch of the Zero Accident Movement at the Annual Safety Award Convention 2012 on 18 September 2012.

However, despite the added emphasis and efforts, there were still several serious accidents that occurred on LTA worksites in the past two years. Hence, Safety Division organised the 4th Corporate Safety Retreat to take stock of the current safety situation, analyse the accident trends and cause, and formulate initiatives to achieve LTA's vision of Zero Accident on our worksites.

PRE-RETREAT

Analysis of Accident Data

To aid in identifying areas for improvement, an analysis was conducted on the root causes of all the accidents that occurred on LTA worksites in the past two years. A total of eight root causes were identified and categorised into three key areas for improvement:

- Mindset and personal commitment
- Competency
- Innovative design and cutting edge technology

Areas for Improvement	Root Causes
Mindset & Personal Commitment	Inconsistent Safety Performance of Contractors
	Poor Safety Performance of New and / or Local Contractors
	Lack of Commitment between Civil and SWC Contractors
Competency	Gaps in Communication and Supervision
	Inadequate Skills Set and Unsafe Attitude
	Gaps in Safe Work Practices
Innovative Design Cutting Edge Technology	Lack of Consideration for Constructability
	Over Reliance on Manual Labour (Recurring Hand Injuries)

Figure 1: Three key areas for improvement in Safety Performance

Pre-Retreat Workshops

In preparation for the 4th Corporate Safety Retreat, the various root causes identified earlier by Safety Division were shared with all the Roads, Rail and Engineering project teams. The Directors / Project Directors heading the various project teams then conducted workshops with their project teams and contractors to brainstorm ideas to address these accident root causes. The strategies and initiatives developed during these workshops would be used subsequently at the safety retreat, allowing the Senior Management to make an informed decision on the way forward.

Pre-Retreat Study Trip

In preparation for the Safety Retreat, Safety Division also organised a study trip to Infineum Singapore Pte Ltd, a petrochemical company located on Jurong Island to glean best safety practices that can be replicated on LTA worksites as well. Infineum Singapore Pte Ltd has been recognised by MOM as a safety excellent organisation at their annual Workplace Safety & Health Awards. The study trip was conducted on 11 December 2014 and included representatives from Rail, Roads and Engineering project teams.

LTA 4th CORPORATE SAFETY RETREAT

The LTA 4th Corporate Safety Retreat was held at Seletar Country Club on 29 January 2015 and was attended by 163 participants consisting of both LTA and Contractors. The retreat was a half day event with the following agenda:

1) Review of past years' safety performances;
2) Setting of safety targets for 2015 to 2020;
3) Presentation and discussion on safety initiatives; and
4) Agreement on the safety initiatives and new safety targets by Senior Management.

Besides the LTA Project Management Staff, young engineers were also nominated to attend the retreat. The approach gave them a good opportunity to learn and be involved in discussions. This would help reinforce them with a safety mindset of ownership and pursuing safety excellence in LTA projects.

In a break from past retreats, the Senior Management from LTA's contractors were also invited to the Safety Retreat. Their involvement in the retreat enabled LTA to get these contractors' commitment and buy-in to LTA's vision of achieving Zero Accident on their respective worksites.

Figure 2: LTA Chief Executive Mr. Chew Men Leong giving the opening address at the Safety Retreat

In his opening speech, LTA Chief Executive Mr. Chew Men Leong took the opportunity to share that LTA believes in investing new technology and providing training to further raise the safety standards on site. LTA is committed to improving the safety and productivity of its workforce by mandating the requirement for more skilled workers in its projects.

Mr. Chew ended his speech by reminding all that as LTA increases its number of projects, one of the greatest challenge is to instil a safety-first mindset, and thus for real change to take place, there must be ownership and "safety starts with each and every one of us".

Figure 3: Discussion on the merits of the initiatives proposed

Proposed Safety Initiatives

Through the presentations made by Safety Division and the Directors, as well as the robust discussions that transpired at the retreat, a total of 16 safety initiatives were shortlisted to be implemented on LTA projects:

1. Compulsory combined Civil / E&M Planned General Inspections
2. Safety considerations in Combined Services Drawings (CSD), Structural Electrical and Mechanical (SEM) and Coordinated Installation Programme (CIP)
3. Safety Engagement Programme (SEP)
4. Mechanise to remove the need for hazardous works
5. Improve on equipment design for ease of bulk handling
6. Establishment of work zones for full responsibility and ownership
7. Corporate safety audits and reviews
8. Empowering senior / experienced workers to take on roles as charge hands
9. Empowering workers to conduct safety training in their native language with demonstrations
10. In-house assessments for supervisors in individual native languages to ensure competency
11. Standardise operational procedures across different projects
12. In-house production of hand injury videos on manual handling
13. Safety induction seminar for new tenderers as a pre-requisite for tender submission
14. Reward scheme by contractors for site supervisors who maintain a safe team
15. Limit in-situ reinforce concrete works with design considerations to enable precast modular elements
16. Strut-less excavation for station construction through Continuous Bored Piles (CBP) with ground anchors

With the 16 initiatives selected, Directors were nominated to champion these initiatives and to ensure that these strategies are carried out effectively across LTA construction sites.

New Safety Targets

The setting of new safety targets was also determined at the Safety Retreat.

Proposed Safety Targets for 2015-2020						
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Accident Frequency Rate(AFR)	0.9	0.81	0.73	0.66	0.59	0.53
Severity Rate(SR)	20	18	16	14	12	11

Figure 4: LTA's Corporate Safety Targets

Figure 5: Group photo of Safety Retreat participants commemorating the event

CONCLUSION

The LTA 4th Corporate Safety Retreat has provided a timely forum for the stock taking of LTA's current safety situation, to better understand the safety challenges faced, close possible gaps in the work process and to forge ahead with new initiatives to achieve LTA's vision of Zero Accident across all LTA projects.

Kevin Seet
Assistant Safety and Health Manager
Safety Division

[4] ENVIRONMENTAL IMPACT ASSESSMENT IN LTA

INTRODUCTION

As LTA embarks on more projects to enhance commuters connectivity and support Singapore's long-term infrastructure development, 'Environmental Impact Assessment' (EIA) is now an indispensable part of our projects. This is a process by which the anticipated effects on the environment of a proposed development or project (during construction and operation) are assessed. If the likely impacts are significant, design measures or other relevant mitigation measures can be taken to reduce or avoid those impacts.

ADOPTION OF EIA IN THE WORLD

Since the 1960s, there has been growing public awareness of the interaction between development actions and their environmental consequences. In developed countries, consistent calls have been made for human health, amenity and ecological concerns to be explicitly considered in development decisions. Initially, the response taken to environmental problems was reactive, focusing on 'end-of-pipe' solutions. However, the value of an 'anticipate and prevent' approach is now recognised, and the focus for environmental action has shifted from rectification to prevention.

Hence, EIA was first introduced in the USA nearly 40 years ago, as a government response to demands for environmental effects to be formally considered in the planning of development projects. Since then, EIA has become a formal process in many countries, and is currently practiced in more than 100 countries. EIA as a mandatory regulatory procedure is also adopted in countries including EU member countries, and even Asian countries like Malaysia, Hong Kong and Taiwan.

While there is currently no regulation to mandate the conduct of EIA in Singapore, the Urban Redevelopment Authority (URA) does have its own requirements for conducting EIA. A set of criteria has been established to identify projects that have the potential in resulting significant environmental impacts, for instance projects that affect sensitive areas (such as nature reserves, marine works), or when projects can potentially cause trans-boundary impact.

PURPOSE OF EIA

EIA process is at times misunderstood as an expensive process that can be an obstacle to development. However, with a clear understanding of the purpose of an EIA, its benefits can far exceed the initial outlay and time spent on the process.

1) EIA as an Important Decision-making Tool

The EIA process plays a major role in supporting rational decision-making in the sphere of development activity. It is not the purpose of EIA to impede development, but is designed to alert the decision maker, regulatory agencies and the public of the environmental consequences of projects, so that these projects can be modified or alternatives can be sourced that might lower the costs of construction, operation or of environmental pollution.

The EIA study provides a means for decision makers to better integrate environmental, human health, socio-economic concerns through systematic examination of the environmental implications of a project.

2) EIA Encourages Environmentally-Sensitive Project Design

Secondly, through the identification of potential environmental impacts from project proposals, design changes or mitigation measures can also be proposed to avoid or reduce the significant impacts. Improved designs can be made through early consideration of project impacts during the design phase, through ongoing discussions between the design team and EIA consultants.

EIA IN LTA

Recognising the value of EIA studies in our development projects, LTA require EIAs to be conducted for major rail and road infrastructure projects even though most of LTA's projects do not fall under URA's criteria. EIA has been conducted for LTA railway lines and expressways (e.g. Down Town Line, Marina Coastal Expressway, Thomson-East Coast Line, North-South Expressway) to evaluate the environmental impacts due to the projects.

EIAs are usually conducted during the Architectural / Engineering (AE) phase, where the objective is to develop mitigation measures to minimise environmental impacts to the physical environmental and human population. Through the use of quantitative, semi-quantitative and qualitative techniques, the EIA Consultants can predict the impact magnitude, evaluate its significance (importance) and identify mitigation measures to minimise the impacts. The remaining impacts (residual impacts) will then be evaluated, and if it is still deemed unacceptable, more mitigation measures will be developed to further reduce them to an acceptable level. The recommendations from the study are then cascaded to the construction phase for the Contractors to adapt for site specific implementation.

HOW EIA IS UTILISED IN LTA'S WORKS

By conducting the EIA study before the construction phase, it allows Contractors and Project Teams to better appreciate the site before construction work commences. The EIA Consultant first establishes the baseline conditions around the site by identification of sensitive receptors e.g. hospitals, schools and residences (Figure 1).

Figure 1: Identification of noise sensitive receptors near upcoming project sites

After establishing the baseline conditions, impact assessments will be conducted. For instance, in the aspect of noise, simulations will be conducted to predict the noise levels on sensitive receptors during the actual work across the different construction phases (e.g. site clearance, excavation, piling, reinstatement). Contours representing the predicted range of noise levels during actual construction works will then be presented (Figure 2). With these simulations, sensitive receptors that may be significantly affected by our works can be easily identified before construction works commences.

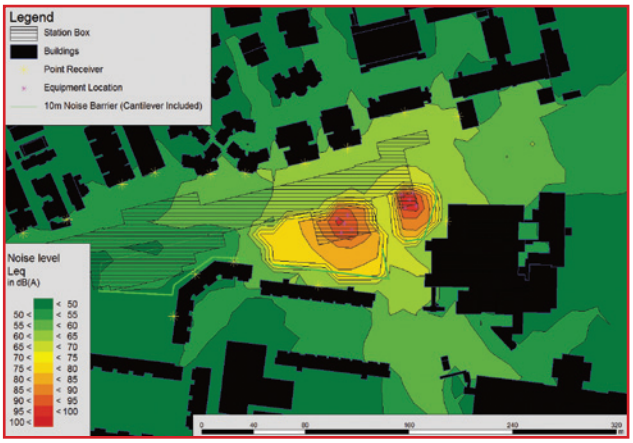

Figure 2: Noise simulation contours reflecting predicted noise levels

With this understanding of potential impacts brought about by our projects, design changes could be incorporated through the change of construction methods or through the identification of effective mitigation measures to reduce the impact on surrounding sensitive receptors. For instance, noise barriers of suitable height and acoustic qualities can be designed and specified upstream prior to the commencement of construction (Figure 3).

Figure 3: Erection of 10m noise barriers on the side facing noise sensitive receptors

IMPORTANCE OF EIA IN OUR WORKS

As seen in the previous section, the use of EIA ensures that the site condition is made known before actual construction work commences. This is especially beneficial to contractors during the tender stage, as they can better appreciate the site challenges and ensure that all mitigation measures that are needed have been planned for and factored into the costs. This prevents the situation where contractors are caught by surprise and resulting in higher mitigation costs. Apart from costs savings brought about by early planning, disruption to projects' timeline can also be avoided. Stop-work orders and fines from regulatory agencies (e.g. NEA and PUB) can be prevented with proper environmental management. This reduces the amount of feedbacks received by our projects and eliminates the need for intervention by enforcement agencies.

Aside from having a better downstream management of environmental impacts, an EIA also demonstrates to concerned stakeholders that LTA had invested due consideration to mitigate impacts and is exceptionally crucial in developing harmonious relations with concerned stakeholders. Through undertaking of EIA, an objective study can be conducted to gain an early understanding of a project's potential impacts and benefits. The public would also be assured that no disruptive developments will be carried out before a comprehensive study is conducted.

MOVING FORWARD – ENVIRONMENTAL IMPACT WORKSHOP AND REGISTER

A new initiative will be implemented starting from TEL Civil Package 5 & 6. To ensure that all environmental impacts are duly identified, properly cascaded and mitigated in the various phases of a project, contractors will be required to organise an environmental impact workshop within the first 2 months upon the award of Contract to update and discuss what will be implemented in response to the impacts and mitigation measures identified in the EIA report. These workshops are not new and similar workshops had been carried out for managing noise in TEL Civil Package 3. This will result in the alignment of all stakeholders and give assurance that proactive measures are taken to address the issues identified in the EIA, instead of reacting to it when the situation arises during construction phase.

CONCLUSION

As compared to other developed countries, Singapore may be relatively new in the field of EIA. However, as the biggest developer in Singapore, LTA is exercising its due diligence in this area of study and looking to build an EIA framework that would make the process structured, standardised and systematic across all projects. As projects continue to roll out, LTA has moved in tandem, balancing the expectations of stakeholders and the needs of sensitive receivers, so that our projects can be delivered on time with minimum impact on the environment.

Lim Yiling
Deputy Environmental Manager
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[6] TEMPERATURE REGULATING MECHANISMS AND HEAT RELATED DISORDERS AT CONSTRUCTION WORK SITES

INTRODUCTION

Singapore, being one degree north from the equator, the atmospheric temperature that one can experience is generally hot and humid. The National Environment Agency has predicted based on weather statistics over the past decades that the highest temperature can measure up to 35°C[1]. With varying environmental conditions that can last throughout the day, the human body generally is able to adapt to the changes.

However, when the human body fails to regulate the exposure to hot weather, the person can easily succumb to heat related disorder that can injure or kill.

This article aims to highlight how the human body copes with high temperatures, the various types of heat related disorders and preventive measures to be taken.

HOMEOSTASIS

Homeostasis is where the body regulates its functions to maintain internal consistency while adjusting to conditions. Homeostasis is maintained through negative feedback mechanisms, and its relation to regulate body temperature is elaborated in the following paragraphs below.

Negative Feedback Mechanisms

Negative feedback happens when there is a need to change its variable back to ideal state. This response will be turned off only when the normal value has been reached.

Homeostatic mechanisms have three components. They are as illustrated:

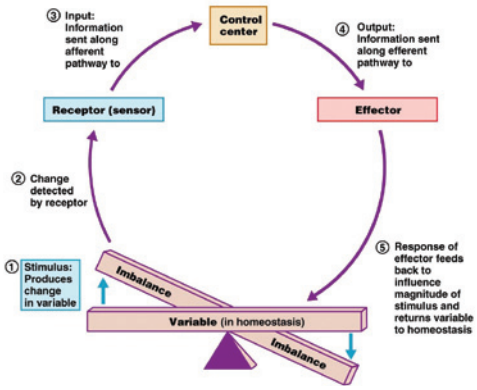


Figure 1: Homeostasis maintained by negative feedback mechanisms

A Receptor is a component that monitors changes in the internal or external environment, and sends information to the control centre. For example, heat is sensed at body's outer surface.

A Control centre determines the range that is normal of a factor. The control centre receives information from the receptors and selects an appropriate response. In regulating body temperature, the control centre is located in the brain.

An Effector is a component that carries out the selected response. In this context, it is the sweat gland.

An example would be, considering the temperature in the external environment is above the body's set point, say 38°C. Firstly, the skin (Receptor) sensed a raise in temperature and the activated nerve cells sends information to the hypothalamus (Control Centre). The hypothalamus decides on the response and sends nerve impulses to the sweat glands (Effector) to increase their secretions. As the secretions evaporate from the skin, it produces a cooling effect, and the body temperature drops to below 37°C. This signal is then feedback to the Control centre, which will cut off the corrective measure when the desired change is achieved. Other forms of response which the hypothalamus may activate include dilation of the blood vessels and relaxation of muscles attached to the hair follicles.

TYPES OF HEAT RELATED DISORDERS

Heat Cramps

Heat cramps can happen after hours of work in a hot environment. Loss of bodily fluid and the inadequate replacement of salt are usually associated with the cause for heat cramps. Symptoms of heat cramps include painful muscle tightness on arms, abdomen, legs, and its onset can be brief or intermittent. One can prevent heat cramps by resting, drinking water or electrolyte fluids (e.g. isotonic "sports drinks") adequately.

Heat Exhaustion

When a person has been exposed to high temperatures over a prolonged period of time, he can be prone to heat exhaustion, as the person's perspiration cannot dissipate the heat generated within the body. This result because of salt and water lost over time, and dehydration occurs. The common signs and symptoms include profuse sweating, rapid heartbeat, dizziness, fatigue, nausea, vomiting, pale and hot skin. If anyone is experiencing signs and symptoms of heat exhaustion, bring the person to rest in supine position in a cool and shady area quickly, and remove extra layers of clothing. Apply cooling measures such as fanning, and provide the person with water or electrolyte fluids. Call 995 if emergency aid is required, or if the person does not recover.

Figure 2: Treatment for heat exhaustion

Heat Syncope

Heat syncope is associated with the dilation of blood vessels, which can cause the blood pressure to fall. This usually occurs with prolonged standing or sudden rising from a sitting or lying position. As a result, less blood flows to the brain, and fainting or dizziness occurs. Other signs and symptoms include light headedness, or a loss of consciousness. Steps to treat heat syncope are similar to the treatment for heat exhaustion.

1. Source: Workplace Safety and Health Council Bulletin, Preventing Heat Stress at Work
2. Source: Workplace Safety and Health Guidelines, Managing Heat Stress in the Workplace

Heat Stroke

Heat stroke is the most severe form of heat related disorder. It is also a form of hyperthermia, where the mechanism for lowering higher than normal body temperature fails. Being considered a medical emergency, death will occur if the person is not promptly or properly treated. Heat stroke can also occur as a progression from the milder forms of heat related disorders. Symptoms can develop quickly when a person is in a hot and humid environment, and physically exerting himself. There are distinct signs and symptoms for persons suffering from heat stroke, and they include core body temperature above 40°C, sweating has stopped, and skin feels hot and dry. The other signs and symptoms are hallucination, confusion, disorientation, seizures, and rapid heartbeat.

It is very important to render first aid treatment to person suffering from heat stroke immediately. Steps include, bringing the person to a cool shady area and fan him, remove any unnecessary clothing, apply cool water to his skin, place ice packs under his armpits and groin area, and call 995 immediately.

Figure 3: An emergency drill conducted on site to educate workers on heat stoke

RISK FACTORS

Risk factors which can predispose a person to risk of heat related disorders are:

Susceptible Individuals

These include persons having poor general health, alcohol abuse, physical exhaustion, dehydration, or ill health.

Clothing

Wearing excess clothing that prevents sweat from evaporating easily.

Unacclimatised Persons

Persons coming from countries of cooler climates, or have little or no experience of working under the heat.

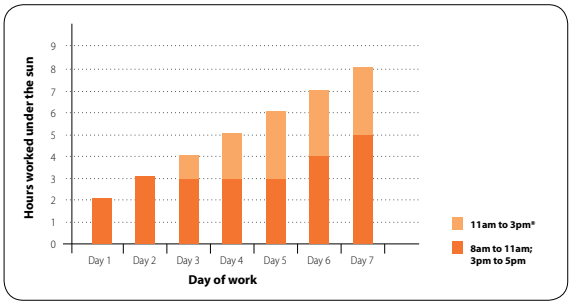
PREVENTIVE MEASURES

Consult a Doctor

Persons feeling unwell or exhibiting symptoms of ill health should seek medical attention prior to the commencement of work.

Acclimatisation

Under the Workplace Safety and Health Guidelines, a person who is not used to working in a hot climate may take up to 2 weeks to be accustomed to the heat and workload. A new worker, especially for those coming from countries of cooler climates, should not start working at full workload upon arrival. Instead, the worker can undergo a 14 day heat acclimatisation program[2]. He can be acclimatised by gradually increasing his exposure to heat and workload over a 2 weeks period. Figure 4 illustrates a gradual increase in exposure to heat over a period of 7 days.



*Assuming that lunch hour is from noon to 1pm and that there are regular rest breaks

Figure 4: Example of acclimatisation schedule[2]

Adequate Water Intake

One can keep himself hydrated by drinking water frequently. Supervisors can play an important role by encouraging their staff to quench their thirst all the time. Workers should also avoid the excessive intake of coffee and alcohol.

Work Scheduling

Whenever possible, avoid heavy physical work during the hottest part of the day (11am – 3pm). Alternating work and rest period, for example, every 5 minutes rest for every 25 minutes of work, should be adopted under moderately hot conditions[2].

Engineering Controls

Provision of fans can increase general ventilation of the physical environment. Provision of Local Exhaust Ventilation to draw heat from high heat production areas can also help.

Shaded Areas for Work and Rests

Temporary shelters should be provided for workers who will spend a significant amount of time under the sun.

Clothing and Training

Persons working in hot climate should wear light coloured and loose fitting clothing, and be educated on how heat related disorders can impact them.

CONCLUSION

Our human body is designed to cope with certain amounts of heat through regulation of our body functions. However, due to occupational demands, physical needs can be neglected and health is compromised. With awareness and effective mitigating measures, heat related disorders are preventable.

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[8] MANAGING DRAINAGE AT WORK ZONE

INTRODUCTION

Roadside drain is an important feature along a carriageway to ensure that the surface runoff can be adequately discharged to minimise water ponding or flooding. Apart from the drainage capacity, there are other issues that must be considered to ensure that the drain will not create a hazard for road users. This article will discuss the various considerations for the proper provision of a roadside drain in the implementation of temporary road works.

a) Alignment & cross-section details

At the design stage, adequate space on the sidetable and centre median, where necessary, have to be catered for to accommodate the drains and this has to be properly coordinated with the provision of other roadside features such as footpath, street lighting, signs, safety barrier, etc.

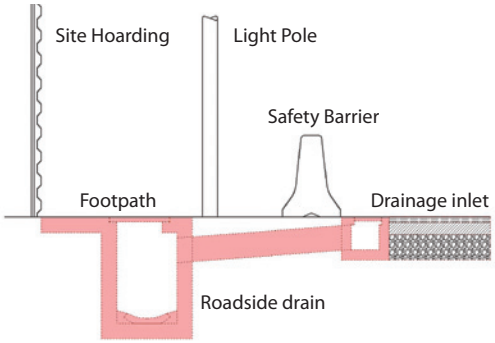

Figure 1: Adequate width along the roadside has to be catered for to accommodate drains as well other roadside features.

Based on LTA Design Criteria, for a straight carriageway section, a desirable minimum crossfall of 1 in 30 and a minimum longitudinal gradient of 0.4% are required to facilitate surface water drainage to the roadside drains.

Figure 2: Crossfall and longitudinal gradient are required along the carriageway to channel the surface runoff to the roadside drains.

For road diversions, it is quite common that a reverse curve is used especially at the interface between the existing and diverted carriageway. A reverse curve is where the road deflects in the opposite direction after the initial road bend. Along the reverse curve, the crossfall and drainage have to be provided accordingly along the inner radius of the road bend (Figure 3). Adverse crossfall happens when the direction of the crossfall slopes towards the outer radius of the road bend. This should be avoided as it will pose stability problems especially for motorcyclists, load-carrying vehicles as well as other vehicles with a high centre of gravity. Care should be taken to ensure that the mid-tangent section of the reverse curve where there is no crossfall does not coincide with the low point of the vertical profile of the carriageway to avoid water ponding.

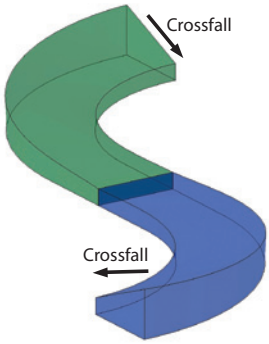

Figure 3: Schematic illustration of a reverse curve with the provision of the crossfall and roadside drain along the inner radius of the road bend.

If a road bend has to be introduced along a multi-lane carriageway, the impact on the road level along the existing sidetable can be minimised by providing a carriageway with a split level along the centre divider with the use of a proper cast-in-situ safety barrier and the provision of a drain along the centre median.

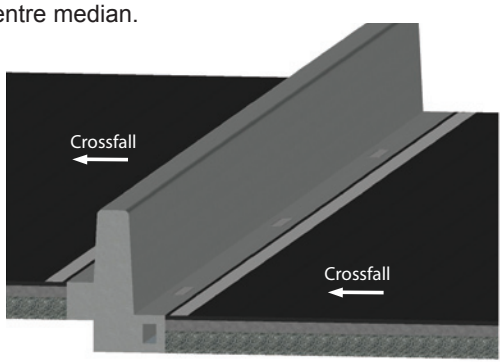

Figure 4: Provision of drainage along the centre median with a split-level carriageway.

b) Proper provision of a roadside drain

Where a precast concrete safety barrier is used, proper drainage inlets have to be provided between the safety barrier and carriageway to ensure that the surface runoff can be properly collected and discharged.

Figure 5: The precast concrete safety barrier segments have been disconnected to create gaps to allow surface runoff to flow towards the roadside drain. However, while this may address the drainage issue, the precast concrete safety barrier will no longer be able to serve its function as a safety barrier and will create undue roadside safety issues.

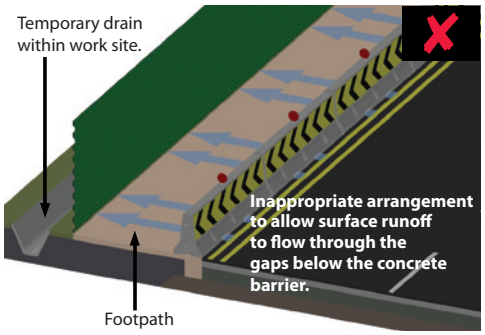

Figure 6: Where a footpath is located behind the precast concrete safety barrier, the surface runoff should not be allowed to flow through the gaps below the precast concrete barrier and across the footpath as this will result in inconvenience for pedestrians and slippery condition along the footpath.A proper drainage inlet could be provided in front of the precast concrete safety barrier to channel the surface runoff below the footpath and into the roadside drain.

If the temporary road works involve the use of non-rigid safety barrier such as w-beam guardrail or unrestrained temporary safety barriers such as water-filled safety barrier, steel or precast concrete safety barrier, adequate lateral offset has to be provided between the safety barrier and open roadside drain to cater for the deflection of the safety barrier when it is impacted by a vehicle.

Figure 7: If the w-beam guardrail is impacted, the impacting vehicle is likely to crash into the open drain as the w-beam will not be able to cater for the vehicular impact. This is due to insufficient space behind the guardrail for it to deflect in order to safely contain and redirect the vehicle back onto the carriageway.

If the required clear zone could not be provided due to site constraints, the roadside drain has to be shifted further away from the carriageway or covered-up to provide the required clear and traversable area behind the safety barrier to cater for the dynamic deflection. Alternatively, a fully restrained temporary safety barrier can be used by anchoring the safety barrier onto the carriageway.

Figure 8: Use of a drain covered with vehicular grating behind the w-beam guardrail which will also allow for the dynamic deflection of the w-beam guardrail when impacted.

c) Provision of a proper drainage inlet

A proper drainage inlet based on the specifications in LTA design standard has to be provided to minimise any potential risk to vulnerable road users such as pedestrians, pedal-cyclists and motorcyclists.

Figure 9: Improper surface openings for drainage inlets along the footpath will create a tripping hazard for pedestrians.

Figure 10: Improper construction of drainage inlets with wide gaps along the carriageway could pose stability problems for cyclists.

Figure 11: The current design standards require the provision of drainage inlets with gratings that are perpendicular to the direction of travel and smaller gaps in-between the gratings.

CONCLUSION

There are many challenges faced in the implementation of the temporary road works to facilitate the timely completion of road and rail projects. The temporary traffic scheme, including the provision of roadside features such as drains and drainage inlets, has to be properly designed for and in compliance with design requirements to ensure that the road system serves its intended function, without compromising on the safety of road users and work site personnel.

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Road System Safety Manager
Safety Division

[10] SAFETY CONSIDERATIONS IN NORTH-EAST LINE ADDITIONAL TRAINS PROJECT

INTRODUCTION

The North-East Line (NEL), operated by Singapore Bus Services Transit (SBST), is a fully automated and driverless rail system powered by a 1500 V DC (Direct Current) Overhead Catenary System. NEL connects the heartlands such as Punggol and Sengkang in the North-East region of Singapore, passing through the Central Business District at Douby Ghaut, and terminates at Harbourfront.

With six carriages per train, the NEL currently has a fleet of 25 trains. To cater to an expected increase in passenger traffic, 18 additional new trains will be added to the existing fleet to enhance the rail capacity. These additional trains are supplied under Contract 751C.

C751C TRAIN FOR NORTH-EAST LINE

Contract 751C has been awarded to Alstom Transport S.A. / Alstom Transport (S) Pte Ltd Consortium for the procurement of the additional new NEL trains. These additional new trains are designed for driverless operation in both the depot stabling areas and on the revenue line, including the sidings with the provision of manual operation control. In addition, they are also fully compatible with the existing NEL system and the fleet of trains in terms of functionality, system interface operability, performance, coupling capabilities and other operating systems.

The immediate questions in mind for the additional new NEL trains would be; how different are they from the existing ones? Are there disparities in safety standards? As technology advances, there will inevitably be variations between the new trains and its predecessors. In fact, with technological advancements and its range of new features, passenger safety is enhanced.

These additional new trains have been carefully evaluated to ensure that their subsystems are similar to that of their existing counterparts. The new trains feature a slew of new improvements, which includes the Dynamic Route Map Display (DRMD), frangible strips, Semi-permanent Coupler and Detrainment Doors. This article will focus on the Detrainment Doors, deformation tube in the Semi-permanent Coupler and the frangible strip.

DESIGN CONSIDERATION FOR DETRAINMENT DOOR

The key consideration in the design of the Detrainment Door is on its deployment in times of need. The Detrainment Door will deploy only when it is safe for the commuters to disembark. This design consideration is aligned with the original design principle, which is paramount to passenger safety.

The design of the Detrainment Door needs to maintain the basic principle of sending an alarm to the Operations Control Centre (OCC) in the event of a physical activation of the door. Upon the request for detrainment made by passenger via the Detrainment Door handle, the Detrainment Door will open automatically after the Automatic Train Protection System (ATP) signalling system confirms that the train is stationary. This operating principle of the existing train's Detrainment Doors will act as the basis for the design of the Detrainment Door for the new NEL trains.

DETRAINMENT DOOR OVERVIEW

The Detrainment Door is fitted at both ends of the new trains and provides an exit for passengers to disembark to the track level when deployed during emergencies. Compared with the existing NEL trains, the main differences between the Detrainment Doors of the new trains are:

New Trains (C751C)	Existing Trains (C751A)
Flip up design	Flip down design
Activation via a handle	Activation via push button
Provision of a windscreen	Solid panel

Table 1: Difference between the new and existing NEL trains

The Detrainment Door of new trains opens upwards and has only 1 leaf. Its operation is purely mechanical, and there is no need for any power source for deployment or stowage as illustrated in Figure 1.

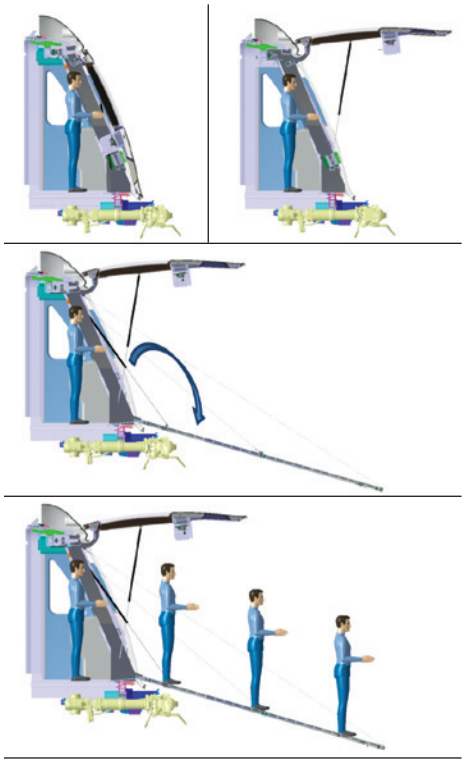

Figure 1: Deployment of C751C Detrainment Door

Figure 2: 3D schematic of the C751C Detrainment Door

1. Semi-permanent Coupler is a mechanism which connects 6 separate train cars to form one 6-car train set

The main advantages of the new trains Detrainment Doors are:

- Manufactured using lightweight material
- Modular design with ramp and structure being one single assembly which allows easy installation on the vehicle
- Provision of a windscreen for enhanced visibility
- Ease of deployment; passenger can deploy simply by following instructions provided. It takes not more than 30 seconds to deploy the Detrainment Door and stowing can be achieved in 10 minutes
- Occupies minimum cabin space, with a simple interface with vehicle.

DEFORMATION TUBE FOR SEMI-PERMANENT COUPLER

Another safety enhancement to the new NEL trains is the provision of a deformation tube in the second half of the Semi-permanent Coupler[1]. The deformation tube is a sacrificial device having a maximum buff stroke of 220mm and a maximum compressive force of 1000kN. This translates to a maximum dynamic absorption capacity of 220kJ. This energy absorption component helps keep forces and accelerations at acceptable levels and prevent unnecessary damage to car bodies. Figures 3 and 4 provide an illustration of the Semi-permanent Coupler and deformation tube.

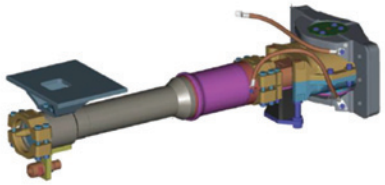

Figure 3: Second half of Semi-permanent Coupler assembly

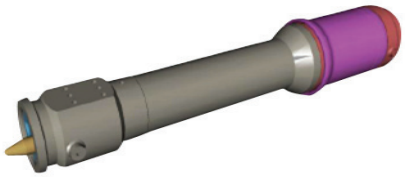

Figure 4: Coupler shank with deformation tube

The basic principle in the operation of a deformation tube is to dissipate energy through the extrusion (widening of the diameter) of a cylindrical tube (depicted in yellow in Figure 5 below).

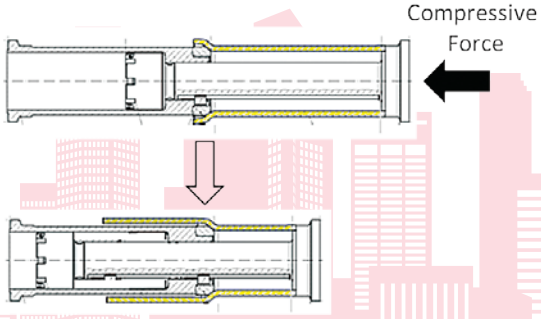

Figure 5: Operating principle of a deformation tube

PROVISION OF FRANGIBLE STRIPS

The new NEL trains are fitted with frangible strips which minimises the stepping distance between the train and the platform edge. The frangible strip (outlined in red) is shown in Figure 6.

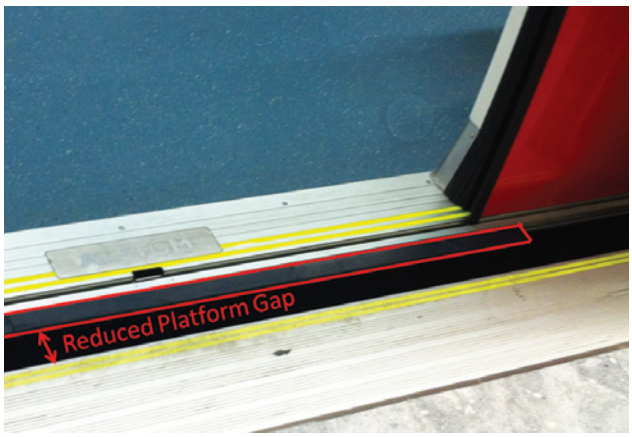

Figure 6: Reduced platform gap due to the use of frangible strips

The provision of the frangible strip for the new NEL trains reduces the likelihood of a passenger's foot being trapped between the station platform and the train.

CONCLUSION

The new trains are fully compatible with the NEL system and existing NEL train fleet in terms of functionality, system interface operability, performance and coupling capabilities. In general, the design of the new NEL trains is compliant with all the applicable design safety principles.

On a concluding note, safety is an integral part of design. Therefore, it is paramount that the design of the new trains is managed with due diligence. Detailed analysis on the design differences between the existing trains and the new trains were conducted to identify and mitigate any new hazards arising from design differences. Hazard management activities have also ensured that all hazard mitigating measures identified for the existing trains are also implemented in the new trains. With the compliance of safety management activities specified within the Systems Assurance Plan, the additional new trains for NEL project was able to demonstrate the achievement of the level of safety specified at the Design Stage.

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LTA 33rd SAFETY WORKSHOP

The 33rd Safety Workshop organised by Safety Division was held on the 29th June 2015 at HSO Auditorium. It was attended by more than 100 officers from Rail, Road Projects and Engineering Groups. The Workshop served as a regular forum for LTA staff to share their technical / practical experiences and challenges faced by them in the delivery of their projects. It also provides a platform for LTA senior management to interact with the site staff.

Four presentations were delivered during the Safety Workshop. The topics presented were:

1. Sharing on LTA Annual Safety & Environmental Performance in year 2014 by Mr. Cheong Zhi Hao, Kenneth, Deputy Safety & Health Manager; and Ms. Low Shi Mei, Assistant Environmental Manager

2. Safety Challenges in NEL Depot Stabling Track Expansion Works by Mr. Tan Hong Kwang, Melvin, Acting Project Manager

3. Safety Considerations of Closing the Temporary Staging Area's roof opening above a LIVE track by Mr. Chua Chee Meng, Principal Engineering Officer

4. Updates on MOM's Operations and the Demerit Point System (DPS) by Mr. Tong Tee Hui, Senior Assistant Director, Occupational Safety and Health Inspectorate, Ministry of Manpower

Figure 1:
Mr. Cheong Zhi Hao, Kenneth
Deputy Safety & Health Manager

Figure 2:
Ms. Low Shi Mei
Assistant Environmental Manager

Figure 4:
Mr. Chua Chee Meng
Principal Engineering Officer

Figure 3:
Mr. Tan Hong Kwang, Melvin
Acting Project Manager

Figure 5:
Mr. Tong Tee Hui
Guest Speaker
Senior Assistant Director
Ministry of Manpower

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