Safety News

Enhancing Workplace Culture

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Introduction

2008 has been the best year to date for the Land Transport Authority (LTA) with respect to Workplace Safety and Health (WSH) performance with an Accident Frequency Rate of 1.33 (accidents per million manhours worked) and an Accident Severity Rate of 31 (mandays lost per million manhours worked). In addition, there had been zero fatality for both 2007 and 2008.

The Journey Begins ......

LTA’s journey towards Workplace Safety and Health (WSH) excellence can be traced back to 1998 when an Executive Safety Committee (ESCM) was set up. The committee comprised of senior management members to oversee and provide leadership on construction safety related issues. Foreseeing the need to oversee safety-related issues from both the “Safe To Build” and “Safe To Use” perspectives, the ESCM was renamed in 2004 as the Corporate Safety Committee (CSC) which is chaired by the Chief Executive.

The LTA’s Safety, Health and Environmental Management Manual (SHEMM) serves as the main guiding document in the management of WSH, with the environmental framework added in this year as LTA is both OHSAS 18001 and ISO 14001 certified. It is stated within LTA’s Safety Policy to “strive for the highest standards of safety consistent with international best practices”.

WSH Leadership

The CSC provides executive decisions while the projects are driven by the Project Safety Committees under the leaderships of the LTA Directors in charge of these projects, for the management of WSH as well as environmental issues.

Dialogue sessions are also held twice yearly between the senior management of LTA and the main contractors on each project to review past performance, share lessons learnt and the way forward in achieving good WSH practices.

WSH Education

Of vital importance is WSH knowledge. The LTA began on a series of educational programs for staff and contractors. First among them back in 1999 was a quarterly in-house publication called “Construction Safety News” which has since been renamed as “Safety News” to provide wider coverage not only on construction safety but also road system safety, rail system safety and environmental issues. This publication is circulated widely to staff and contractors, as well as industry partners in WSH.

Much focused efforts had been devoted by senior management, project management and the support teams such as Safety Division over the past decade in the journey towards world class WSH standards.

This article aims to provide an understanding on the WSH management framework and a glimpse of the history of creating a sustainable WSH culture within LTA and its contractors.
In-house safety workshops are also held regularly to promote sharing of information, experiences and lessons learnt from challenging or interesting projects.

**WSH Promotion**

Safety promotional work is an integral part of creating a sustainable WSH culture. In 1999, the LTA Annual Safety Award Convention (ASAC) was launched to give due recognition to contractors who have excelled in WSH performances. The 10th ASAC was held last year.

Due recognition is also accorded to LTA officers for their efforts in managing WSH on the worksites. This is done through two separate schemes:

- For individual officer: Construction Staff Safety Awards for the most safety conscious officer from each project.
- For project team level: Project Safety Commendation Award for the best performing project safety committee.

**WSH Enforcement**

The enforcement program includes the worksite physical condition checks, site audits and administrative measures. Firstly, there is a structured regime of WSH inspections conducted jointly between project teams and the main contractors:

- Weekly: led by the Senior Project Engineer
- Monthly: led by the Project Manager
- 3-monthly: led by the Deputy Director
- 6-monthly: led by the Director

Secondly, annual internal audits are conducted by LTA’s Safety Division on project teams and their contractors on the implementation of safety, health and environmental measures in compliance with SHEMM.

Thirdly, there are administrative programs such as the Safety Performance Scheme (SPS) and the Safety Incident and Infringement Reporting and Notification (SiREn) Scheme. SPS is a “carrot and stick” approach implemented in all major civil contracts since 2004 and very positive results have demonstrated its effectiveness in improving WSH performance through pro-active self-regulation by contractors. SiREn is a voluntary and confidential whistle-blowing scheme that allows any site personnel to report any infringements or practices observed on-site which could lead to potentially serious consequences.

**WSH Engineering**

As a responsible developer, there is a lengthy set of WSH requirements, with many requirements above those stipulated under current legislation that contractors must comply with while working within LTA’s projects. It is continuously updated based on lessons learnt and good practices from completed projects. A good example is the stringent requirements involving lifting operations resulting in zero crane-related dangerous occurrences in 2008 in all its worksites.

The LTA also implemented a hazard management process called Project Safety Review (Safe-To-Build) to manage civil related hazards throughout the five typical stages of its projects: Feasibility, Concept, Detailed Design, Construction and Handover. It is a process to ensure integration of engineering safety and WSH into project planning and management. A dedicated database called Project Hazard Database System (PHDS) is used to monitor the hazards until they are properly closed.

There is a web-based platform used internally, Safety Information Management System (SIMS), to record accidents, incidents and WSH related data in its worksites. The objectives are to promote transparency of lessons learnt, monitoring of statistics and trend analysis. “Near misses” reporting are encouraged to disseminate lessons learnt to prevent the occurrence of more serious accidents.

**Summary**

The above write-up gives a quick snapshot of the WSH management framework within LTA. It has been a successful journey so far to bring LTA to where it is right now with the support and commitment of its staff and contractors. Moving forward, it is now timely to pursue a sustainable WSH culture within the subcontractors and their workforce for world class WSH standards!
Introduction

With the launch of the Land Transport Master Plan (LTMP) in 2008, the ambitious goal of expanding the Rapid Transit System (RTS) network from 138km today to 278km by 2020 means major investments in new lines and extensions. It was with this backdrop that our senior management decided to engage DuPont Safety Resources again to conduct an assessment of our Occupational Safety and Health Management System (OSHMS). The end in mind is for LTA to deliver the LTMP projects with world class safety performance standards.

As with the previous audit in January 2007, Mr. James O. Faulk was the auditor from DuPont. Having Mr. Faulk to audit us again provided continuity as he would be able to assess the improvements made since the previous audit. As part of the audit process, Mr. Faulk conducted numerous interviews with our senior management, project management teams and our contractors. In addition, a thorough review of our OSHMS documents and visits to our various worksites were carried out during the audit period.

In this audit, the LTA scored an impressive 4.07 points out of a possible five. In simple terms, it means that the LTA executes most recognized best practices in occupational safety and health routinely and consistently. This result also places the LTA in the top 5 to 10% of organizations worldwide in safety excellence.

According to Mr. Faulk, the LTA’s key strength lies in the fact that our management has the willingness and ability to improve upon the safety performance following the 2007 audit. Notably, there have been no fatalities and the Accident Frequency Rate (AFR) had improved from 1.56 in 2007 to 0.84 (at the time of the audit) for 2009. This is no mean feat considering the number of infrastructure projects and the challenging nature of these projects.

There were notable improvements in scores of most of the audited elements as compared to the 2007 audit findings. This is evidence of the hard work and dedication that LTA has invested in the pursuit of excellence in management of OSH within the LTA at all working levels.

As with the previous audit, Mr. Faulk was very impressed with the LTA’s Project Safety Review (PSR) process for civil projects which seeks to integrate safety and health matters into project planning and management, right from the design stage, through the construction and maintenance phases and eventually to its demolition. He also commented LTA on its tender evaluation where the tendering contractors’ OSH track records and risk management techniques are closely scrutinized.
However, despite the excellent audit score, Mr. Faulk strongly recommended the LTA to strive in strengthening officers’ safety observation skills as well as to enhance investigation process into near-miss cases. He believed that by doing so, the LTA will be able to progress to a higher safety performance level.

Following the DuPont’s audit findings and recommendations, the LTA held the 2nd Safety Retreat on 22nd June 2009 at the Serangoon Garden Country Club. As in the previous retreat in 2007, LTA’s top management, the engineering and project management teams gathered with a common purpose, i.e. to chart the way forward in bringing LTA’s safety performance to a higher level.

Table 1 shows the targeted yearly improvement of the corporate safety figures for both the Accident Frequency Rate (AFR) and Severity Rate (SR) from 2009 to 2012 that were deliberated and agreed upon by the participants. These figures represent a 5% yearly improvement in our targets.

**New Corporate Safety Targets**

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accident Frequency Rate (AFR)</strong></td>
<td>1.33</td>
<td>1.26</td>
<td>1.20</td>
<td>1.13</td>
</tr>
<tr>
<td><strong>Severity Rate (SR)</strong></td>
<td>31</td>
<td>29</td>
<td>28</td>
<td>27</td>
</tr>
</tbody>
</table>

Table 1: New corporate safety targets

**Safety Initiatives**

To achieve the set targets, the participants agreed that new strategies were needed to steer LTA’s safety performance to greater heights. Hence, in addition to DuPont’s recommendations, a slew of safety initiatives were proposed by the various participants and debated at length. The following is a summary of the initiatives that were proposed:

1. Sharing of knowledge and experience between LTA and its contractors;
2. Behavioural-based safety;
3. All subcontractors to attain at least bizSAFE level 3;
4. Dedicated officers from safety division for respective project directors;
5. Joint LTA / Contractor safety retreat (Friends of LTA);
6. Contractors to reinvest payouts from the Safety Performance Scheme; and
7. Cash bonus for project team whose contractor wins the ASAC challenge shield.

**Conclusion**

Just like the grueling F1 race, LTA’s journey towards safety excellence is a long haul journey with the recently concluded DuPont audit just one of the many pit stops along the way.

This audit allowed us to take stock of how far we have come in terms of safety performance and what is required of us to bring our performance to a higher level. And just like the refueling and tire change at a F1 pit stop, the 2nd LTA Safety Retreat provided us with a new impetus and strategies to bring LTA’s safety performance to greater heights and with this, LTA will be able to deliver the LTMP projects with world class safety performance standards.
**Introduction**

Over the years, Samwoh Corporation Pte Ltd has earned itself excellent safety records based on a strong belief and commitment that all incidents are preventable and that the safety and health of each employee is of paramount importance.

This safety commitment was recognised by the LTA when Samwoh received the Certificate of Excellence at the LTA Annual Safety Award Convention 2008 for two projects – ER146 and ER200.

In October 2008, Samwoh was awarded the bizSAFE Partner Certificate, and subsequently attained bizSAFE Star level in May 2009. This is a testimonial of Samwoh’s commitment to upholding the standards set by the Workplace Safety and Health Council.

**The Journey in Building bizSAFE in Samwoh**

Safety should go hand in hand with business. Samwoh believes that under no circumstances should the safety and health of the employees be compromised in any work considerations. The introduction of bizSAFE into Samwoh aids in monitoring the safety and health practices at the worksite.

With the necessary preparations prior to work commencement, the identified hazards, its associated risks and mitigation measures are communicated to site personnel at the front line of work activities. Daily toolbox meetings and safety talks are platforms for conveying the information effectively.

**Level 1: Demonstrate Top Management Commitment**

Samwoh recognises the essentials of a good safety, health and environment policy to provide guidance for the company. Samwoh states the commitment to minimize risks to all stakeholders, including employees and members of public, as well as preserving the integrity of the environment. This commitment is supported by the top management and is a collective responsibility of all employees of Samwoh Corporation Pte Ltd.

**Level 2 & 3: Acquiring, Conducting and Implementing of Risk Assessment**

At the start of any project, a risk assessment team consisting of the Project Manager, Project Engineers, Safety Personnel, Site Manager, Site Supervisors and other stakeholders is established to brainstorm and develop safe work procedures coupled with comprehensive risk assessments.

Safety inspections led by the Project Manager are conducted regularly. Planned General Inspections are carried out jointly with the LTA project team. For all non-compliances identified during the inspections, Samwoh imposes direct ownership of safety by ensuring that all corrective actions are carried out by respective project personnel.

In addition to undertake all precautionary measures in ensuring a safe worksite, any emergency scenarios must also be anticipated. As part of the Emergency Preparedness, all Samwoh personnel are trained in handling emergencies to protect stakeholders, properties and the environment.

**Level 4 & 5: Acquiring and Implementing a Workplace Safety and Health Management System (WSHMS) certified to OHSAS 18001**

A WSHMS certified to OHSAS 18001, is implemented and effectively managed in Samwoh to comply with the relevant WSH acts and regulations.
Site personnel are important assets at workplace. To ensure safe delivery of work, it is of great importance that site personnel are trained and deemed competent in handling work demands. Recognising this fact, Samwoh believes in continual training and development for all employees.

Besides the standard infringement penalty system, Samwoh has instilled a new behavioural-based reward system for its supervisors and operators, including its subcontractors. This system rewards personnel for advocating safety at worksites and will not condone unsafe acts and practices.

Samwoh made arrangement with a bizSAFE service provider, GreenSafe International Pte Ltd to set up a bizSAFE Performance Monitoring System, enabling Samwoh to monitor each of its subcontractor’s bizSAFE status. The bizSAFE service provider assists and coordinates with the subcontractors to register for the bizSAFE courses to reach bizSAFE Star level, and also the procedures to receive the eligible financial assistance from the RMAF. The bizSAFE service provider will communicate with Samwoh on any updates of its subcontractors’ bizSAFE status. This way, Samwoh will be able to monitor and encourage subcontractors to join in the journey to bizSAFE.

By the year 2010, Samwoh expects all of its subcontractors to attain at least bizSAFE Level 3 Certification. In addition, the safety performance records of subcontractors will be taken into consideration before employment of works and during performance appraisal.

**Conclusion**

Samwoh cares for everyone; besides its own stringent safety standards enforced on site, Samwoh believes that its subcontractors should also display similar WSH standards. The bizSAFE Programme will not only help the subcontractors build up their WSH capabilities, it also gives recognition for their safety efforts and thus gives them the competitive edge among other SMEs.

Samwoh aspirès for all its subcontractors to demonstrate an equal degree of commitment towards safety and health at workplaces. An additional contractual clause had been inserted in its contract agreement for every sub-contractor to attain at least bizSAFE Level 3 within 6 months of work commencement. Therefore, besides fulfilling Samwoh’s obligations as a bizSAFE Partner in raising the safety performance of small & medium enterprises (SMEs), the purpose of the seminar is to aid Samwoh’s subcontractors in gaining an in-depth knowledge about the bizSAFE programme, Risk Management Assistance Fund (RMAF) and to guide them through the bizSAFE road map, eventually leading to the bizSAFE Star.

Tokens of appreciation were presented at the seminar to the subcontractors as a demonstration of their commitment to raise their safety and health standards.
Good Hygiene & Health Practices at Construction Sites

Introduction

This article is dedicated to protect the workforce on our sites by highlighting two areas of possible concerns relating to hygiene and health issues:

- Physical contact with hazardous/contaminated materials.
- Location of workers dormitories.

Good Hygiene Practices

Wash Your Hands!

Proper hand washing is one of the most underestimated yet effective methods of curbing the spread of infectious disease and preventing the ingestion of contaminants and bacteria. This is especially important for our workforce at construction sites. As the nature of their job requires them to handle excavated soil, reinforcement bars and even chemicals, it is thus important to remind all workers to thoroughly wash their hands after using the toilets, before having meals and after they cough or sneeze.

The 7-Step Hand Washing Technique

Proper hand washing is not merely about placing your hands under running water. The objective is to remove any transient microorganisms that may be acquired through daily chores or contact with another person. For a start, wash your hands using soap and water, followed by the 7-step shown below:

- Always remember to pat dry your hands after washing. In the absence of soap and water, alcohol-based (60%-95%) hand sanitizer can be used as well.

Malaria Transmission in Singapore

Singapore has been declared malaria free since 1982. However, a total of 28 locally transmitted malaria cases have been recorded since May 2009. So how did the virus enter Singapore?

The answer lies in the foreign workers. Singapore is located in a region where most of our neighbours are malaria endemic countries. Workers coming from these countries may have already been infected by malaria. These parasites can stay dormant in a human body for up to a year and could be difficult to detect unless through the use of Polymerase Chain Reaction (PCR) test. PCR tests are highly specific and sensitive for detecting the malaria virus.

The Human Host

Workers infected with the malaria virus and managed to enter Singapore are human hosts in the transmission cycle. If they are part of the construction workforce, it is likely that they will be staying in dormitories housing workers from other countries. Workers coming from non-malaria endemic countries have no immunity to malaria and are especially susceptible to the virus.

The Vector

Even with the above factors present, it is still not possible for transmission to occur. As Anopheles mosquitoes prefer to live and breed in vegetated/forested areas, the likelihood of a HDB/apartment dwelling Singaporean coming into contact with an Anopheles mosquito is low.

Unfortunately this is not the case for the foreign workers. Most of the dormitories are sited away from the residential estates and are often near to forested areas. Transmission will hence take place when an Anopheles mosquito bites an infected worker staying near a forested area and then bites another person. The 2 malaria clusters in Singapore are located in Sungei Kadut / Mandai and Jurong Island.

Protecting the Health of our Workforce

To ensure that our workforce is safe from malaria, the following measures are encouraged:

- All foreign workers staying on/near sites in the vicinity of forested areas should have their blood samples taken and sent for PCR test before their first day of work.
- Every bed in the dormitory should have a mosquito net that is preferably treated with long-lasting insecticide.
- Carry out indoor residual spraying of insecticide.
- Windows should be fitted with nettings to prevent mosquitoes from entering the dormitory.
- Thermal fogging if required should be carried out at night (about 10pm) when Anopheles mosquitoes are most active.

Conclusion

In our quest for a greener and safer working environment, it is important that we pay equal attention to the health of the workforce. After all, a strong and healthy workforce is a sustainable workforce!
Introduction

A road accident can either occur within the carriageway, for example a rear-end collision involving other vehicles, or it can also occur beyond the carriageway, for example when a motorist loses control of the vehicle and it veers off the carriageway into the sidetable.

One of the principles of road safety engineering is to ensure that motorists are able to recover safely in the event that their vehicles veer off the carriageway. Roadside Hazard Management is a procedure to ensure that adequate steps are taken to identify potential roadside hazards and to implement the appropriate hazard mitigation measures.

What is a Roadside Hazard?

A roadside hazard is any rigid structure located off the carriageway which, if impacted, could result in an injury to the occupants of the vehicles.

The table below indicates the relative degree of severity of the various types of roadside features located in different road environment:

<table>
<thead>
<tr>
<th>S/n</th>
<th>Roadside Feature</th>
<th>Design Speed (km/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>≤ 70</td>
</tr>
<tr>
<td>1.</td>
<td>Non-rigid safety barrier</td>
<td>2.0</td>
</tr>
<tr>
<td>2.</td>
<td>Rigid safety barrier</td>
<td>2.0</td>
</tr>
<tr>
<td>3.</td>
<td>Rigid base protruding more than 100mm above vehicle trajectory</td>
<td>5.0</td>
</tr>
<tr>
<td>4.</td>
<td>Posts, poles and trees</td>
<td>100 dia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>200 dia.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 dia.</td>
</tr>
<tr>
<td>5.</td>
<td>Impact on on-coming vehicle</td>
<td>7.5</td>
</tr>
<tr>
<td>6.</td>
<td>Impact on stationary vehicle</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Table 1: Road hazard index table
(Source: Road Design Guide, New South Wales, 1996)

Clear Zone Concept

The fundamental principle of Roadside Hazard Management is the provision of a clear zone. A clear zone is basically a traversable area along the roadside where errant vehicles can recover by themselves by gradually decelerating to a safe stop without impacting any roadside hazards.

The following table below indicates the lateral clear zone requirements along the roadside:

<table>
<thead>
<tr>
<th>Design Speed</th>
<th>Clear Zone Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 60 km/hr</td>
<td>4.5m to 5.0m</td>
</tr>
<tr>
<td>70 km/hr</td>
<td>6.0m to 6.5m</td>
</tr>
<tr>
<td>90 km/hr</td>
<td>6.5m to 7.5m</td>
</tr>
</tbody>
</table>

Table 2: Recommended lateral clear zone distance required for various speed limits for flat terrain condition and high traffic volume
Roadside Hazard Management

Typically, in an urbanised road environment such as in Singapore, providing the required clear zone could be challenging due to land constraints. Under such circumstances, a risk assessment has to be undertaken by evaluating the likelihood and severity of a collision involving the roadside hazard. Based on the risk assessment, the appropriate roadside hazard management measures will then be undertaken to mitigate the risk associated with the hazard. The various measures are as follows:

- Remove (most preferred option)
- Relocate
- Retrofit
- Shield
- Delineate (least preferred option)

Removing the Hazard

The first consideration is always to remove the roadside hazard to provide the required clear zone.

Relocating the Hazard

If the roadside feature is required, it should preferably be located where there is a relatively lower risk of vehicles veering off the carriageway.

Retrofitting the Hazard

If the hazard cannot be removed or relocated, then the roadside feature can be redesigned such that it will not create a roadside hazard while still being able to serve its intended purpose.

Shielding the Hazard

If the road hazard cannot be relocated or retrofitted, it has to be shielded using an appropriate type of road safety barrier.
Delineating the Hazard

Delineation is generally used when the hazard cannot be removed and is intended to guide motorists along the carriageway to reduce the likelihood of motorists making mistakes and veering off the carriageway. Typical delineation devices include curve alignment markers, delineator poles, object marker and raised pavement markers.

Water-filled barricades are only meant for delineation purposes and it should not be used as a road safety barrier. It will not prevent errant vehicles from penetrating the barricades.

Requirements for the Road Safety Barrier

A road safety barrier is intended to be forgiving in nature. While it is necessary to contain the impact of the errant vehicle to prevent penetration, an impact on the barrier should not be so severe that it compromises the safety of the vehicle’s occupants and other road users.

While sheet-pile barriers are robust enough to prevent penetration, the rigidity of the barrier may result in excessive damage and injury. The impacting vehicle may also be deflected to such an extent that it encroaches into the adjacent lanes and result in secondary collision.

Due to the dynamic nature of a vehicular impact, all road safety barriers have to meet the requirements of the evaluation standards for road safety device such as the National Cooperative Highway Research Program (NCHRP) Report 350 and BSEN 1317.

Highlights of the main factors that are evaluated under NCHRP Report 350 are as listed:

- The detached elements, fragments or other debris of the safety barrier should not penetrate into the vehicle’s compartment;

Use of Road Safety Barriers

A road safety barrier is a device that is used to shield roadside features by containing the impact of the errant vehicle and redirecting it back onto the carriageway.

In a work zone, road safety barriers are used to provide a physical segregation between the carriageway and the roadside to prevent vehicle penetration which could affect the safety of pedestrian, work site personnel and even the occupants of the errant vehicle themselves.

Typically road safety barriers are used to shield steep embankments, vertical drops and open drains, sharp road bends, rigid roadside structures and deep excavations.

Figure 8: Use of curve alignment markers to delineate the road bend

Figure 9: Use of delineator poles to guide motorists at a road bifurcation within the work zone

Figure 10: Water-filled barricades for delineation purposes

Figure 11: Sheet-pile barrier
• There should be no undue hazards to traffic, pedestrians or personnel in the work zone;
• The vehicle should remain upright after the collision;
• The vehicle occupant’s impact velocity and ride-down acceleration should not exceed the allowable limits; and
• The vehicle’s path following an impact should not intrude into adjacent lanes.

Even though it is possible to design a barrier to comply with the relevant structural design codes to withstand the impact forces of a vehicle, the crashworthiness of the barrier cannot be established without subjecting it to a full crash-test and evaluating the performance based on the standards described earlier. Therefore a road safety barrier should only be selected from a type-approved list. The safety barrier also should not be modified and it has to be installed based on the complete system which has been crash-tested and evaluated.

Different types of road safety barriers have been developed for various road environment, both for permanent as well as temporary installations at work zone. Other than those specified in the LTA’s Standard Details of Road Elements, international roading authorities such as the Federal Highway Administration (FHWA, United States) also provide a list of both proprietary as well as non-proprietary safety barriers that meet the evaluation requirements of NCHRP Report 350.

Road Safety Barrier Selection

Generally the 2 categories of road safety barriers are:

1. Non-rigid road safety barrier
2. Rigid road safety barrier

A non-rigid road safety barrier will dynamically deflect to contain and redirect the errant vehicle. This type of road safety barrier includes the w-beam and thrie-beam guardrails.

For non-rigid road safety barriers to function effectively as intended, there should be sufficient clear and traversable area behind the safety barrier to allow for full deflection when impacted. For w-beam guardrail with a post spacing of 2.0m, the required clear zone is 1.0m. Any roadside hazards within this clear zone has to be removed, relocated or retrofitted. The required deflection zone can be further reduced by using stiffer type-approved safety barrier such as the thrie-beam guardrail.

If the clear zone is not available, for example on a vehicular viaduct or along a work zone where there is a deep excavation, then a rigid safety barrier can be used. Unlike non-rigid safety barrier, the containment and redirection of an errant vehicle is achieved by the surface profile of the rigid barrier itself. The impact energy is dissipated as the vehicle glides along the traffic face of the rigid safety barrier.

Conclusion

To ensure the safety of the road system, while every effort has to be made to minimise the occurrence of a traffic incident, appropriate roadside hazard management is also necessary to provide a forgiving roadside environment to minimise the risk of injury to the vehicle’s occupants and other road users.
Introduction

The technique of Hazard and Operability Study (HAZOP) has been used and developed over approximately four decades for identifying potential hazards and operability problems caused by deviations from the design intent, primarily in the process industry.

HAZOP was first developed by Imperial Chemical Industries (ICI) in the United Kingdom back in 1960s and was progressively adopted by other industries with similar potential for major hazards, such as the petroleum industry.

When applying HAZOP to a railway or road project environment, which systems will be built and commissioned accordingly to the design, it will lead to better service quality and safety.

What is HAZOP?

HAZOP is a formal, systematic examination of the engineering facets and human interactions of complex systems, identifying and assessing the consequences of potential hazards deviations from the design intent.

• **HAZOP I** is a systematic examination of the system using keywords to identify hazards that manifest themselves in the operational environment. High-level hazards, such as Fire, Smoke and Collision of railway system are considered in HAZOP I.

• **HAZOP II** is a systematic examination using detailed engineering flow/line diagrams. Potential deviation from the design intent is identified with the help of guidewords. Detailed development of accident scenario, treatment of people-equipment interactions, system interactions, system operability and failures mechanisms are examined more closely in HAZOP II.

Why Conduct HAZOP?

Safety and reliability in the design of systems usually relies upon the application of various Codes of Practices (CPs), or design codes and standards. It is important to supplement an anticipation of deviations which might occur, for instance: equipment malfunction or operator error. It is a widely used method to identify and provide comprehensive knowledge of hazards within complex systems. The HAZOP is an opportunity to correct these hazards at an early stage before complicated and costly modifications need to be executed.

HAZOP is most effective as a team effort, bringing together the perceptive contributions of equipment designers, operating personnel and safety experts. Its application has been shown to result in better informed personnel and facilitation of procedural controls to cost-effectively improve the safety and reliability of complex systems, such as railways, hence fewer commissioning and operational problems surfaced.

Team Composition

It is most important that the study team chosen can provide the knowledge and expertise that is appropriate to the project to be studied leading to the success of the HAZOP study. The team should be suitably small to ensure efficiency whilst with skills and experience necessary to cover the area of study comprehensively.

When to perform HAZOP?

The HAZOP can be conducted early in the concept design stage as well as during detailed design phase. Although HAZOP was originally devised as a means of identifying problems at the design stage of a project, the technique may also be performed on an existing facility to identify modifications to be implemented to minimise risk and operability hazards.

How to perform HAZOP?

**Pre-HAZOP Activities**

It is most important to structure the meetings correctly, with the aim of considering first the most significant operations in generic terms in HAZOP I followed by detailed consideration in HAZOP II.

Taking a typical railway project for example, daily operations in the depot would be considered at a broad level, i.e. depot operations. This will be followed by a HAZOP II study in considering those operations in greater detail i.e. wheel turning in the depot. One main consideration is the comprehensiveness of the study, which should be balanced against the level of available resources and the likely value to be obtained from a detailed study.

Prior to any HAZOP session, the chairman shall produce the ‘HAZOP Members Information Pack’ and distribute to the Members prior to the planned HAZOP session. The purpose of the HAZOP Members Information Pack is to provide sufficient background information to participants to ensure a common knowledge base for HAZOP application. The chairman should also produce a chairman’s pack which would contain sufficient information of the HAZOP subject area including, where possible, results of similar sessions, in order to support the optimisation of the chairman’s role.
Study Process

In the HAZOP I session, the chairman will present the team a list of keywords which serve as a platform to help prompt the team to identify hazards. The two main considerations in HAZOP I sessions are:

1. Potential hazards related to the design.
2. Potential operability problems related to the design.

Examples of keywords are as shown below:

<table>
<thead>
<tr>
<th>KEYWORDS</th>
<th>MEANING</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal Faults</td>
<td>None of the design intent is achieved.</td>
<td>1) Signal link not re-established following maintenance. 2) Damaged connector.</td>
</tr>
<tr>
<td>Track Faults</td>
<td>Quantitative increase in a parameter.</td>
<td>1) Overcurrent; regulator failure / false feed. 2) Overcurrent; operator error.</td>
</tr>
</tbody>
</table>

Table 2: Examples of guidewords

In the HAZOP II session, the chairman commences by choosing a component on the design representation as a starting point. The project E&M representative then explains its design intent. A checklist of guidewords is used to generate deviations from normal or expected modes of operation corresponding to all conceivable possibilities.

Output of HAZOP Studies

The output from a HAZOP study should include the following:

- Information of identified hazards and operability problems together with details of any provisions for their detection, and/or mitigation;
- Recommendations for any further studies of specific aspects of the design using different techniques, if necessary;
- Actions required for addressing uncertainties discovered during studies;
- Recommendations for mitigation of the problems identified based on the team’s knowledge of the system; and
- Notes which draw attention to particular points which need to be addressed in the operating and maintenance procedures.

Key Success Factors

The key success factors to conduct a good HAZOP session are:

- Drawings and data used for the study should be accurate;
- An experienced HAZOP team leader;
- A team which is well-equipped with technical skills and insights;
- A team which is well-versed in using the HAZOP approach as an aid to identify deviations, causes, and consequences; and
- The team should maintain a sense of proportion, especially when assessing the severity of the potential consequences.

Implementation on LTA RTS Projects

HAZOP has been applied not only to new systems such as the Sengkang-Punggol LRT, North East Line and Circle Line but even to RTS extension projects such as Changi Airport Extension and the recent Boon Lay Extension. In those sessions, experts from core systems such as the rolling stock, signalling, communication and integrated supervisory system as well as the operator combed through the design and operation modes in order to ascertain that all foreseeable potential hazards have been examined.

Summary

In summary, HAZOP is an essential tool for hazard identification and has been used successfully to improve the safety and operability of both new and existing systems. The rigour of this identification process applied to LTA’s RTS projects had provided the management the confidence that the systems built had addressed and mitigated all foreseeable hazards, thus providing a safe system to the public.
2009 Accident Statistics*

*C Based on Workplace Safety and Health Act Requirements

**CUMULATIVE ACCIDENT FREQUENCY RATE**
(AF R)

**CUMULATIVE SEVERITY RATE**
(SR)

**CUMULATIVE FREQUENCY - SEVERITY RATE**
(FSI)
Annual Safety Award Convention (ASAC) 2009

ASAC gives recognition to the LTA's contractors who have been most proactive and successful in safety, health and environment efforts. The significant yearly event will be held in conjunction with the 2nd World Roads Conference this year in Suntec Singapore Theatre on the 28th October 2009. As ASAC enters its 11th year, a new challenge shield will be presented to the ASAC champion. Do keep a lookout of the highlights of the event in the next issue of the safety news.

ASAC 2009 Trophy Design Competition

The ASAC Trophy Design Competition which ended on 15th June 2009 was well-received by staff and contractors.

On 7th September 2009, the winners of the ASAC 2009 Trophy Design Competition gathered and received their prizes from CE. Congratulations to the winners!

Building Safety and Health in Business

The LTA Academy is now an Approved Service Provider (ASP) by Ministry of Manpower to conduct the bizSAFE training programme for SMEs.

bizSAFE Programme is an initiative taken by the Workplace Safety and Health (WSH) Council to promote WSH through recognition of the safety efforts contributed by the aspiring SMEs. To start the bizSAFE journey, the SME’s top management will have to attend the “Workshop for CEO/Top Management” conducted by ASP.

Interested parties of SMEs who are keen to sign up for the “Workshop for CEO / Top Management” or like to know more about the bizSAFE programme can contact the following:

Person-in-charge: Tan Jway Kwee / Yoong Yew Meng
Tel: 63326133 / 63326137
Course Venue: LTA Academy
Address: No. 1 Hampshire Road, Singapore 219428

New Singapore Standards

SPRING Singapore has published 2 new Singapore Standards. They are:

• SS 548 : 2009 on Selection, Use and Maintenance of Respiratory Protective Devices (Formerly CP 74)
• SS 549 : 2009 on Selection, Use, Care and Maintenance of Hearing Protectors (Formerly CP 76)

For more details, interested parties can purchase the Singapore Standards from SPRING Singapore.

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Safety Tan says…

A workplace with excellent safety culture is one where everyone thinks safety, acts safely and works safely.

Make safety your responsibility.