9. HAZARD

9.1 Introduction

The proposed Route 10 (NLYLH) (Southern Section) passes within the Consultation Zone of the new Tai Lam Chung Pre-Chlorination House (PCH) near Tai Lam Reservoir in the north-west New Territories. As the PCH will use and store liquefied chlorine in 1 tonne drums it is classified as a Potentially Hazardous Installation (PHI) under the terms of the Hong Kong Planning Standards and Guidelines, Chapter 11. A Hazard Assessment study is therefore required to assess the risks to the transient population of Route 10 (NLYLH) for comparison against Government Risk Guidelines.

A Hazard Assessment for the Sham Tseng Link was carried out as part of the STLFS in 1996. This study concluded that the risks due to the PCH were acceptable in relation to Government Risk Guidelines. The HAR (STLFS) recommended that the off-site emergency plan for Tai Lam Chung PCH should include emergency actions relating to that part of Route 10 (NLYLH) passing within the Consultation Zone.

The Route 10 (NLYLH) EIA Study Brief requires a review and, if necessary, an update of the 1996 Hazard Assessment report. Section 9.2 summarises the key changes in data since the STLFS. Section 9.3 then assesses the effect of these changes on the HAR (STLFS). Finally, Section 9.4 draws conclusions as to the acceptability of Route10 (NLYLH) in relation to Government Risk Guidelines.

9.2 Review of Changes since HAR (STLFS)

Since the HAR (STLFS), various changes have occurred as summarised below:

Traffic Forecasts

The traffic forecasts (peak vehicle flows) have approximately doubled, as shown in *Table 9.1* below.

Table 9.1 AM Peak Traffic Forecasts for Route 10(NLYLH)

Type of Vehicle	No of vehicles per hour	
	HAR (STLFS)	Route 10 (NLYLH)
Public Transport	67	940
Goods Vehicles	1989	4520
Private Vehicles	2474	4450
Total	**4530**	**9910**

The significant increase in forecast traffic flows would be expected to result in a corresponding increase in the societal risk assessed for Route 10 (NLYLH) due to Tai Lam Chung PCH.

Route Alignment

The alignment has been refined, resulting in a minor change in plan but an increase in elevation from about +20mPD to +60mPD.

The change in elevation is generally beneficial from the point of view of the risk posed by Tai Lam Chung PCH. This is because chlorine gas is heavier than air and tends to remain close to the ground.

So Kwun Wat Interchange

The So Kwun Wat interchange includes a new link road, the Siu Lam Link lying within the Consultation Zone of Tai Lam Chung PCH. *Table 9.2* gives the forecast traffic flows for the Siu Lam Link.

Table 9.2 AM Peak Traffic Forecast for Siu Lam Link Road

Type of Vehicle	No of vehicles per hour
Public Transport	320
Goods Vehicles	2480
Private Vehicles	1620
Total	**4420**

The presence of the new link road will increase the societal risk for Route 10 (NLYLH) due to the Tai Lam Chung PCH.

Tai Lam Chung and Siu Lam

The previously enclosed Tai Lam Chung viaduct and the Siu Lam Tunnel have been replaced by open stretches of road. This change will also result in an increase in the societal risk for Route 10 (NLYLH), due to the increased length which is exposed to the effects of a chlorine release from the PCH.

9.3 Update of HAR (STLFS)

9.3.1 Revised Risk Results

A simple update of the HAR (STLFS) has been undertaken, taking into account the changes summarised in Section 9.2. No changes have been made to the assessment methodology.

The change in elevation from +20m to +60m PD has been modelled by excluding the transient population associated with the Tai Lam Chung viaduct from the calculations. This is considered reasonable as the viaduct passes across the valley at 40m above ground level, ie above the level at which road users could be significantly affected by a passing chlorine cloud (maximum cloud height in 1996 Hazard Assessment was 30m).

The revised Hazard Assessment results are presented in *Figure 9.1* ('FN' curve) and *Table 9.3* (Potential Loss of Life values).

Table 9.3 Potential Loss of Life (PLL) Values for Route 10 (NLYLH)

Assessment Study	PLL (per year)
HAR (STLFS)	1.9×10^{-5}
Route 10 (NLYLH)	7.0×10^{-5}

From *Figure 9.1* it can be seen that the FN curve shifts into the low 'ALARP' region of the Risk Guidelines as a result of the various changes in the assessment assumptions. This means that risks must be reduced to 'as low as reasonably practicable', usually measured as a trade-off between the risk reduction achievable and the cost of implementation of the risk reduction measures.

From *Table 9.3* it can be seen that the Potential Loss of Life (PLL) value for Route 10 (NLYLH), which is a measure of the overall societal risk, increases by a factor of 3.6 compared to the HAR (STLFS). This is due to the inclusion of the Siu Lam Link Road and the increased traffic forecast.

Individual risks to the transient population will remain unchanged from the HAR (STLFS), approximately 10^{-7} per year, which are within the Risk Guidelines of 10^{-5} per year.

9.3.2 Risk Mitigation

The assessment which has been undertaken may be regarded as conservative in assuming that a chlorine cloud drifting over the road would reduce traffic to a crawl, thereby increasing both the exposure time and the total number of people affected. Furthermore the assessment of truck maneuvering accidents (the largest contributor to risk) is considered pessimistic, as noted in the HAR (STLFS).

In this context, the encroachment of the 'FN' curve into the low ALARP region of the Risk Guidelines is not considered significant. In any case the expenditure which would be justified on further risk mitigation measures is not significant, as can be shown by a simple calculation:

Maximum justifiable expenditure on risk mitigation measures
(assuming risk could be reduced to zero)

= PLL value (per year)
x plant operating lifetime (years)
x value of life (HK$)

Using the values commonly used in Hazard Assessments in Hong Kong, the maximum justifiable expenditure may be calculated as follows:

Maximum justifiable expenditure $= 7.0 \times 10^{-5} \times 30 \times 23 \times 10^{6}$
$=$ HK$48K

Clearly such a sum does not justify major changes.

The HAR (STLFS) already recommends improvements in off-site emergency planning for Tai Lam Chung PCH, in line with accepted best practice for major transport routes. It is considered that this provides sufficient mitigation given the low level of risk.

9.4 Conclusions

9.4.1 Operational Phase Risks

Various changes have occurred since completion of the HAR (STLFS), they are

- an increase in forecast traffic flows (by approximately a factor of 2);
- changes to the route alignment;
- inclusion of the Siu Lam Link; and
- replacement of previously enclosed sections of road with open sections.

The impact of these changes is to shift the societal risk 'FN' curve into the low 'ALARP' region of the Risk Guidelines. However, it is considered that the risk from Tai Lam Chung PCH is as low as reasonably practicable, and hence acceptable, subject to implementation of the risk mitigation measures recommended in the HAR (STLFS). The recommendations of the HAR (STLFS) are repeated below for completeness.

9.4.2 Construction Phase Risks

The HAR (STLFS) concluded that the construction phase risks would be small in relation to the operational phase risks. The number of construction workers within the Consultation Zone of Tai Lam Chung PCH is currently estimated to be 200 normally but up to 500 maximum (previously assumed to be 90 in the HAR (STLFS)). However, as the estimated number of road users has also increased, it is considered that the construction phase risks will be less than the operational phase risks and hence compliant with the Risk Guidelines.

9.5 Recommendations

The following recommendations have been made in the HAR (STLFS) to ensure that the risk levels remain within acceptable limits, throughout the design, construction and operational phases of the project:

(1) Risk levels have been shown to be acceptable on the basis of the information on changes to the traffic forecast, route alignment, road linkage and tunnel arrangements used for preliminary design. Any changes to these data should result in a review of the Hazard Assessment.

(2) If the construction staffing levels exceed 500, it should be referred to EPD to determine if a further HA is required prior to the commencement of construction.

(3) The off-site emergency plan for Tai Lam Chung PCH should be extended to include emergency actions relating to that part of Route 10 (NLYLH) lying within the 1km Consultation Zone. In the event that a chlorine release could be drawn into one of the enclosed section of the route (such as via the ventilation building for the Lam Tei Tunnel) the emergency plan should ensure that the relevant ventilation fans are quickly shutdown to minimise the ingress of chlorine.

In addition, the following recommendations should be followed:

(4) The number of construction workers within the Consultation Zone of Tai Lam Chung PCH should be minimised as far as reasonably practicable.

(5) The responsibility for the emergency procedures (referring to item 3 above) relating to Route10 (NLYLH) lies with Water Supplies Department (WSD) (to warn the operator, either directly or via FSD) and the Route 10 (NLYLH) operator to implement relevant actions in the TLC PCH Emergency Plan (EP) (as revised in accordance with recommendations to this EIA). There will also be a need for liaison with the FSD and the Hong Kong Police Force (HKPF), whose duty is to cordon off the affected area at an appropriate distance from Tai Lam Chung PCH. The procedures relating to Route 10 (NLYLH) should be included in the FSD's Emergency Plan for the PCH.