

HIA Guidelines and Practice Manual



(Enamel Paint)

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Downstream Petrochemical Industry

(Enamel Paint)

By

Department of Health Ministry of Public Health

Preface

The development of industrial sector in Thailand has been growing very fast especially petrochemical industry. This occurred after the large resources of natural gases was discovered in Thai gulf in B.E. 2541. One of the world largest petrochemical industrial complex is in Rayong, and there are several downstream and continuous petrochemical industries in almost every provinces. The positive impact of the development are better economics and wellbeing of the general population while the negative impact could occur to the environment which turn to impact on human health and wellbeing directly. To prevent and mitigate the impacts the tool such as environmental impact assessment (EIA), and health impact assessment (HIA) has been created and deployed. HIA is analysis process of the policy, plan, and project which may have negative and/or positive impact on health. Thus it should be conducted before implement the plan, policy or project so that the improvement plan and/or preventive measures could be proposed to the decision maker. The most important of HIA is that all stakeholders can involve or participate in the process.

When the government has decentralization policy, the Act has been issued and plan and procedure has been set up to transfer the authority to the local administration in B.E. 2542. Part of the roles of the local administrative obtained from the Ministry of Industry is supervision on the factory and receive the notice of the commencement of the operation including inspect the factory under complaint. While the Department of Health agrees that all projects that may impact on human health including the factory should conduct the HIA before having the permission to build the project. The Department of Health by the HIA Division realizes that HIA guidelines and practical manual for downstream petrochemical industry should be developed. As a case study, an enamel factory was selected, so that the local authority personnel who is responsible for HIA and all stakeholders can use as reference for learning and practice in community HIA. Thus, the impact assessment of such kind of project could be conducted systematically, correctly and appropriately. Furthermore, it can be used as a tool to assist in decision making process for permission, supervision and planning of the development of the local authorities. However, the application of the guidelines and the process were not limited to only the downstream petrochemical industry, but can apply to any project, plan and policy as well.

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Chapter 1 Introduction

1.1 What is health impact assessment (HIA)?

Health Impact Assessment (HIA) is an analysis process of public policy, plan or project that may have negative or positive impact on the health of a population, both in national and local level, by applying the knowledge in the fields of risk assessment, epidemiology, social impact, economy, and environment in order to propose appropriate actions to manage those impacts. The negative impact should be control and the positive one should be promoted. Thus, HIA must be conducted before start the policy, plan or project. For community HIA, it is the process that people in the community should work and make decision concerning the development policy, plan or project that may impact on health together. HIA is a tool for healthy community which can be tailor made for each community. The process should facilitate people in the community to involve in all activities. Hearing is widely used tool for the community to get the participation of their people in order to have all direction though and prevent the impact on health, wellbeing, environment, social, and economics.

1.2 Objectives of the guideline are:

1.2.1 To be a HIA guideline for the painting factory project.

1.2.2 To be a guideline for applying to any kind of public policy, plan or project in the community level.

1.2.3 To be a guideline for suggestion the prevention and mitigation measure and the follow-up period and evaluation.

1.2.4 To be a resource about painting factory and its HIA

1.3 Scope of the guideline.

This is HIA guideline for downstream petrochemical industry, specifically enamel painting factory. However, the application to the other project/plan/policy that is not needed to conduct EIA or EHIA is allowed especially that the local administration offices and the community.

1.4 Target groups.

People who should use the guidelines are:

- Community leaders.
- Local administration officers.
- Public heath personnel.
- Project owners.
- General public interested in HIA.

1.5 Terms and definitions.

1.5.1 Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

1.5.2 Health determinants are factors known to directly or indirectly impact an individual's health. Known determinants of health such as individual factors, individual behaviors, public services and infrastructure, living and working conditions, and social, economic, and political factors. (National Institute for Health and Clinical Excellence; NIHCE, 2006). These could be divided in two groups, i.e. 1) social environment such as public services and infrastructure; living and working conditions, and 2) physical environment such as soil, air, water, etc. (Dahlgren and Whitehead, 1991).

1.5.3 Health status is a status of physical and mental health, wellbeing, disease and illness of the population.

1.5.4 Vulnerable groups mean group of people who live in the areas where the pollutants can reach, the transportation routes pass, and the activities of the project running, especially group of children age of 0-4, pregnant women, elderly, poverty, social disadvantage and sensitive to the risk factors (Notification of the Department of Factory B.E. 2552).

1.5.5 Risk factors mean physical, chemical and biological factors arise from or result of the activities of the project/plan/policy in the level that may cause impact to health of the risk groups. (Oder of the Department of Factory B.E. 2543)

1.5.6 Stakeholder means person, group, or organization that has interest or concern in the project/plan/policy. Could be divided into 7 groups: 1) Loss or gain benefits, 2) Organization or unit who responsible for writing the HIA report, 3) Organization or unit who responsible for consider the report, 4) Related governmental offices, 5) Private

organization or NGO or academic institute, 6) Public medias and 7) general population. (ONEP B.E. 2549)

1.5.7 Risk is chance or probability of undesired event to occur and cause negative health impact. (Order of the Department of Factory B.E. 2543)

1.5.8 Community means group of people who live nearby and surround the project and may be affected by the development of the project get together in order to assist or support each other to run lawful and moral activities together for benefit of the members. The action is continuous and systematic management and expresses the intention of the group (Notification of the Department of Factory B.E. 2552).

1.5.9 Pollutant means any substance, as certain chemicals or waste products, that render the air, soil, water, or other natural resource harmful to quality of environment and human health.

1.5.10 AEGL-1 is the airborne concentration, expressed as parts per million or milligrams per cubic meter (ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

1.5.11 AEGL-2 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.

1.5.12 AEGL-3 is the airborne concentration (expressed as ppm or mg/m3) of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

1.5.13 ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr. without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

1.5.14 ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action.

1.5.15 ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects

1.5.16 IDLH (Immediately Dangerous to Life or Health) is an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere. (OSHA, 29 CFR* 1910.120)

1.5.17 TLV (Threshold Limit Values) is a level to which it is believed a worker can be exposed day after day for a working lifetime without adverse health effects. There are 3 kinds of TLV: 1) Time weighted average (TLV-TWA) - average exposure on the basis of a 8 h/day, 40 h/week work schedule; 2) Short-term exposure limit (TLV-STEL) - spot exposure for a duration of 15 minutes, that cannot be repeated more than 4 times per day with at least 60 minutes between exposure periods; and 3) Ceiling limit (TLV-C) - absolute exposure limit that should not be exceeded at any time (The American Conference of Governmental Industrial Hygienists, ACGIH).

1.5.18 PEL (PEL- Permissible Exposure limit) is a legal limit in the United States of America for exposure of an employee to a chemical substance or physical agent.

1.5.19 REL (REL- Recommended Exposure limit) is an occupational exposure limit that has been recommended by the United States National Institute for Occupational Safety and Health (NIOSH). NIOSH's role is research institute on OH&S. IDLH have been proposed by NIOSH as well.

1.5.20 IARC (International Agency for Research on Cancer) is an intergovernmental agency forming part of the World Health Organization of the United Nations. Its role is to conduct and coordinate research into the causes of cancer.

1.6 Concepts of HIA.

HIA should be carried out before a project/plan/policy is approved or got the permission. This ensures that the HIA can impact the associated decision and the changes can be made to the project/ plan/policy. HIA can be conducted in several methods; however in this manual the widely used method composed of 6 steps as shown in Figure 1 will be presented and summarized as the following:

1) Screening involves determining whether a HIA is feasible, timely, and would add value to the decision-making process.

2) Scoping creates a plan and timeline for conducting a HIA that defines priority issues, research questions and methods, and participant roles.

3) Health risk assessment by creating an existing conditions profile for a geographic area and/or population in order to understand baseline conditions and to be able to predict change. Evaluating potential health impacts, including the magnitude and direction of impacts, using quantitative and qualitative research methods and data. Steps can be summarized as:

- Analysis of the project/plan/policy.

- Gathering community information.

- Collecting qualitative and quantitative data according to the scoping.

- Health risk analysis

- Prioritize the risk

- Establish recommendations for improving the project/plan/policy and/or to mitigate any negative health impacts.

4) Report. There are 2 steps: *Creating written or visual presentation of the HIA results* can take many forms including written reports, power point presentations, and comment letters; and *communicating the results* within the decision-making process. A communications plan can include media outreach and public testimony.

5) Monitoring tracks the impacts of the HIA on the decision-making process and the decision, the implementation of the decision, and the impacts of the decision on health determinants.

6) Impact and outcome evaluation. The potential outcomes of a completed assessment should also be evaluated and monitored. This includes: Impact evaluation - the influence that the assessment had on decision-making; and outcome evaluation - evaluating the predicted impacts. The latter is difficult to do because of the complex, multi-causal pathways; however monitoring programs can be designed to include an evaluation of public health outcomes and the assumptions and predictions from the HIA.



Figure 1 HIA processes

1.7 Health determinants.

In the context of HIA, health is a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity, therefore HIA covers both physical and mental health such as illness death, and behavior, neighbor, environment, economics, and politic as well. WHO Commission on the Social Determinants of Health (2008), health status is determined by a range of factors, including, genetics (5%), health care (10%), behavior (30%), and social conditions (55%). (Figure 2)



Figure 2 Health determinants

1.8 Collaborations in HIA.

HIA process should be carried out by a HIA steering committee which composed of diverse group of stakeholders who have influence on the decision-making process such as community organization officer or staff, local administration officer, related government officer, project owner's representative, land owner, and HIA experts, community residents; advocacy organizations staff; public agencies staff (e.g., public health, planning and economic development, transportation, etc.; academics; elected officials; business, industry and developers; and service providers.

The benefits of having a diverse group of stakeholders to participate in the HIA are: understanding differing perspectives; building relationships with the community; identifying resources and expertise; establishing opportunities for future relationships; developing political connections, etc. Therefore in all HIA process should have stakeholders participating in all steps especially in scoping.

Roles and responsibilities of HIA steering committee members.

1) Process oversight. Develop collaboration agreement for conduct and oversight of HIA process; and oversee HIA process (coordinate partners and activities for each step of the HIA).

2) Screening. Identify criteria for selection for HIA projects; Understand decision and decision-making context; Contact other stakeholders and decision-makers; Research funding opportunities; Prioritize health issues to be studied; Judge strength of evidence; Understand competing stakeholder positions.

3) Scoping. Conduct issue identification; Prioritize research questions for HIA; Broaden spectrum of stakeholders involved; Identify health pathways and equity effects; Identify sources of information and data; Establish timeline and boundaries; Consider resources available and develop work plan.

4) Assessment and Recommendations. Research baseline conditions; Lead or participate in field observations and research; Develop and conduct surveys, interviews, and focus groups; Interpret results of local data collection; Help connect variety of data sources to answer research questions; Statistical analysis; GIS mapping; Document review; Field visits and field measures; Secondary data review; and Identify evidence-based mitigations and recommendations.

5) Reporting. Write, review, and edit final HIA report and publications (e.g., letters, testimony); Prepare comments for regulatory process; Interpret / prioritize HIA findings and recommendations; Develop presentations of findings; Communicate HIA findings to decision-makers; Advocate for inclusion of health in decision; and Create demand for public agencies to conduct HIA.

6) Monitoring and evaluation. Monitor decision outcomes and long term results; Hold decision-makers accountable for agreements and mitigations.

There are many levels of stakeholder engagement; the International Association for Public Participation has divided the engagement into 5 levels which can be used with the HIA well, as follows:

1) Informing. To give the stakeholders information about the project/plan/policy by public relation, report, and newsletter.

2) Consultation. To collect the information from the stakeholders by go to the community around the project area to meet and collect the stakeholders' comments on the project.

3) Involvement. To ensure that the stakeholders' thought and comments are considered, their representative involve especially in the scoping and reporting.

4) Collaboration. To be the member of the steering committee and the stakeholders' representative involve in all HIA process.

5) Empower. The HIA stakeholders, including vulnerable populations, decide on scope, have final approval of HIA report, and decide on communication strategy.

The level of engagement of the stakeholders depends on many factors, e.g. type of the project/plan/policy, readiness of the steering committee and groups of stakeholders. Thus the committee should clearly define the level of engagement before starting HIA process.

Chapter 2 HIA of the downstream petrochemical industry project (Enamel Factory)

An enamel factory was selected for a case study as an example for HIA of downstream petrochemical industry Project. Production process (Appendix A) and surrounding factors would be analyzed in order to develop the health indicators, evaluation method and prevention and mitigation measures including monitoring the health impact. The guideline to consider the health is in the Figure 2 and examples are in Table 1 and initial information of the case study needed for HIA is in Frame #1.

Health determinants	Examples
Social, economics and	Poverty, Inequality, Social cohesion and inclusion,
politics factors	Political participation
Living & working	Housing adequacy, air, soil, and water, quality,
conditions	Community noise, Disease vectors
Infrastructure and public	Education, Public transportation, Health care, Parks,
services	Community centers, Economic development
Personal behaviors	Diet, Physical activity, Addictions, Coping, Transportation
Individual factors	Genetic makeup, Gender, Age, Existing health conditions
	and Disabilities

Table 1 Health determinants and example

Frame #1

Scenario: the project owner plans to build an enamel factory on 200 rai on Bangna-Trad road. He'd like to have HIA conducted to assist his decision making. He asks for cooperation from public health personnel to run HIA for him. All expense can be charged to him. According to his plan the factory composed of five one-story plants and one three-story office building.

Frame #1 is the information to consider if HIA should be carried out or not. The information will be used for screening the project in or out of HIA. Normally, the owner must have the detail of the project/plan/policy in hand.



Layout of the factory and surrounding area.

Frame #2

Enamel manufacturing industry is downstream petrochemical which use products of the up-stream and intermediate petrochemicals as raw materials, e.g. organic solvent and resin. The products of the enamel industry are wood stain color, paint, lacquer, vanish, thinner, urethane, etc. They are used in several kinds of industry such as automobile industry, packaging industry, shipyard, electronics, etc.

Frame #2 is the information to consider which factors or issues could have impact on health of the concerned people. Thus the factors which may impact on health will be screened in to HIA process. Normally, the project owner may provide there information and/or the team have to review the literatures.

2.1 Screening

2.1.1 Project screening. To make sure if the project is a good candidate for HIA or not. That is, the project may impact on concerned people's health and well-being including the social and economic or not. In addition, HIA could add value to the decision making process or not. The screening tool is a set of question presented in Tool #1 is composed of initial information obtained from the project owner.

Tool #1						
Project screening for HIA						
Example:						
Screening Questions						
1. Has a project, plan or policy been proposed?						
2. Is there sufficient time to conduct an analysis before the final decision is made?						
3. Does the decision have the potential to affect environmental or social						
4. Would health inequities he imported? In what ways?						
4. Would health inequities be impacted? In what ways?	-	-				
people impacted, the magnitude, breadth and/or immediacy of impacts?	N					
6. Do evidence, expertise, and/or research methods exist to analyze health impacts of the decision?						
7. Is health already being considered in the proposal or as part of the decision-						
making process?						
8. Are the links between the proposal and health or health determinants clear?						
9. Is the decision-making process open to the HIA and/or recommendations for						
changes to design, mitigations and/or alternatives?						
10. Would HIA findings and recommendations potentially improve the impact that the proposal has on health?	\checkmark					
11. Have public concerns about the health impacts of the decision been voiced or	-	-				
documented?						
12. Are the stakeholders and interest groups involved in the decision-making process?						
13. Do stakeholders have the capacity (resources, skills, etc.) to participate in the HIA?						
14. Would stakeholders use the HIA to inform or influence the decision-making process?						

- = uncertain or no not applicable

In case that the answers of the Tool #1 seem to show that HIA will be useful to decision making process of the project owner and the project may cause health impact on the concerned people, the HIA should be carried out otherwise should not.

2.1.2 Studied issues/factors screening. This step, the project will be reviewed for both negative and positive impacts in all phases in order to identify health hazards. Tool #2, a set of question, is used to screen for health hazards by the HIA team. Brain storming is a good method for the hazard identification considering the information in Frame #1, 2 & 3 (the detail of the project/plan/policy should be attached to the request or propose form for permission) and experience of the team. Examples of the screening are in Table 2.

Frame #3

Enamel factory project will be established on Bangna-Trad road, Bangsoatong, Smuthpragran, on 200 rai area. Scope and time line of the project:

Construction phase; Activities and time line:

- Preparing the area for construction takes approximately 30 days.
- Build 6 buildings takes 7 months.
- Start up the plant on the ninth month. There will be approximately total of 2000 workers work in the factory, about 420 works in the enamel plant.

Operation phase, the products launched to the market will be water based paint, oil based paint, spray paint for automobile, and clear lacquer. The amount expected to be in the market is 32 million gallons/year. In order to achieve this target, it must have:

- Raw materials and chemicals such volatile organic solvents (app. 5000 liters/day), resin (app. 5 tons/day), pigments (app. 100 kg/day), and additives (app. 50 kg/day)

- Transportation for raw materials and chemicals to the factory 30 trucks/day and

Transportation for goods to the customers approximately 80 trucks/day.

The production lines run 24 hours a day, therefore there are three 8-hrs work shifts. The numbers of the worker in each shift are:

- Morning shift (8.00-16.00 hr.) 1000 workers.
- Afternoon shift (15.00-24.00 hr.) 520 workers
- Night shift (23.00-8.00 hr.) 480 workers.

To facilitate the travelling to work of the workers, there are 12 buses for morning shift, 9 for afternoon and 6 for night shift.

Information in Frame #3 may be useful in consideration for chance of the impacts to occur. Normally the project owner must have the detail of the project/plan/policy which includes such information.

Health hazards	Risk group					
Dust, smoke, exhaust from construction activities e.g. digging, building, heavy	Workers &					
machine working.	community					
Noise from machine and transportation which may annoy or cause hearing loss.	Workers &					
	community					
Landform and construction may result of piles of dirt and construction materials.	Workers &					
Furthermore, there will be a lot of trucks carrying construction materials supplying to	community					
the site. They may obstruct and impede the road transportation. Accident could occur.						
Construction waste and waste from the living of the workers may be disposed	Workers &					
improperly.	community					
Communicable disease and contagious disease may happen due to poor sanitation in	Workers &					
construction area.	community					
People concerns and worries about the accident due to the operation of the project.	Community					
Workers and their families immigrate to the project area for work.	Workers					
Income and number of employed may reduce or increase for some groups of people	Workers					
in the project area.						
Conflict or argument between people in nearby communities and workers; or	Workers &					
assemble for unlawful purposes.	community					
Accident in the construction such as electrical shock, falls, etc.	Workers					
Operation phase						
Most of solvents are volatile organic compounds with the health effect of central	Workers/					
nervous system depression and some is flammable, thus high risk of fire and health	community					
effect in case of chemical spill.						
Vapor, metal, and dust from production process and empty chemical containers.	Workers/					
(review chemicals in Table 1 as well)	community					
Vapor, metal, and dust from improper waste disposal including empty chemical and	Workers/					
raw materials containers.	Community					
Chemical emergency such as spill, explosion, fire due to a lot of chemicals stored in	Workers/					
the factory.	Community					
Garbage from canteen and office.	Community					
Noise and vibration due to the production; low intensity of light	Workers					
Muscle pain due to carry and move the products and raw materials.	Workers					
Traffic jam due to increasing number of staff's cars, employee buses and trucks	Community					
transporting goods, chemicals, and raw materials; road accident could be increase						
and the inconvenience of road transportation.						
Workers/employees and their family move in the area, thus number of population	Youth,					
increase; several business have been promoted, e.g. rental apartment, convenience	Community					
store, etc. then, unemployed people in the community could be reduced.						
Drug problem may occur due to transportation business which may bring teenagers	Youth,					
and drivers to meet and may lead to other social problems.	Community					
Insufficient medical and health services.	Community					

Table 2 Expected health hazards arise from the project/plan/policy and risk groups.

Once the project/plan/policy is screened for HIA, health impact or determinant factors should be screened. Both negative and positive impact should be considered using Tool #2.

<u>Tool #2</u>								
Health issue/risk factor screening for HIA								
Example:								
	Po	tent	ial I	mng	nct•	Comments		
For each of the following categories,						Specify which acreat of the		
does the project have a potential	Ve	ve	ral	nou		Specify which aspect of the		
impact on	Positi Negativ	leut	n' k	N/A	project was the source of the			
		Ne	Z	\mathbf{D}_{0}		impact		
	1. (Qual	lity a	of life	e			
1.1 Traffic attributable						Land forming and construction		
						<u>causes traffic jam</u>		
1.2 Drug use?								
1.3 Compulsive gambling?								
1.4 Crime problem								
1.5 Community violence								
1.6 Prostitution problem								
1.7 Cultural and arts								
1.8 Community attractions								
1.9 Teenage pregnancy								
1.10 Accident								
1.11 Economic and income of profit in								
community								
1.12 Access to health care service								
1.13 Utilities								
1.14 Resource efficiency								
1.15 Land development								
1.16 Community clean and tidy								
1.17 Education								
1 18 Waste management								
2. P	hvsid	cal e	nvir	onm	ent			
2.1 Pollution (dust smoke fume)		v v				Dust smoke emission from		
		v				construction activities		
2.2 Polluted water								
2.3 Soil quality								
2.4 Garbage								
2.5 Hazardous								
2.6 Stench								
2.7 Noise		2				Noise of machines used for		
2., 10150		v				construction and of		
						transportation		
3	н	[[ealt]	h sta	tus				
3.1 Exercise								
3.2 Pestilence								
J.2 Festilence								

<u>Tool #2</u>							
Health issue/risk factor screening for HIA							
Example:							
For each of the following categories Potential Impact: Comments							
does the project have a potential impact on		e al now			Specify which aspect of the		
		Negativ	Neutr	Don' ki	N/A	project was the source of the impact	
3.3 Adverse health effect							
3.4 Abortion							
3.5 Abnormal among newborn child							
3.6 Illness among children and elderly.							
	4.	St	ress				
4.1 Satisfaction							
4.2 Feeling of safety							
4.3 Comfortable							
4.4 Supportive relationships with neighbors							
4.5 Access to community information							
5.	Nat	tura	l cala	amit	y		
5.1 Flooding							
5.2 Storm							
5.3 Wildfire							
5.4 Landslide							
5.5 Barrenness							

Both negative and positive impact factors are selected for scoping in next step. Then identify mitigation measures in order to control negative impact and promotion measures to enhance the positive impact. Un-related or non-applicable factors will be dropped out, while uncertain or unknown factors need further study to consider if they have, or do not have impact or unrelated.

2.2 Scoping

The health impact factors and health determinants are screened using Tool #2; then the following questions should be asked to the HIA team and stakeholders (in case of public hearing is held) to specify methods, tools, roles of the team, and areas to study.

- What are the initial or present conditions relating to health determinants?
- How this project/plan/policy impact on those existing conditions?
- What will be used to identify or measure the initial conditions and the impacts?

- Where to collect the information or data on each of the indicator?
- Which method will be used to evaluate the initial conditions and expected

impacts?

- How to set priority of the research question and/or indicator?
- How to consider, which research questions and/or indicators should be in the scope of study.

These questions are in the Tool #3 as in the following example.

Tool #3									
Scoping									
Example 1 Health outcome /Determinant: <u>dust, smoke, emission</u>									
Research question Impact Research Questions Methods Responsible par									
What are the existing/baseline	Road traffic on Bangna -	Search for airborne dust	Local public health						
conditions related to the health	Trad road.	concentration or ask	officer.						
determinants (<u>dust, smoke,</u>		people in the community.							
automobile emission)?									
How will the project, plan, or	Add up dust/smoke	Measurement	A representative						
policy impact baseline	concentration.	/observation	of						
conditions (dust, smoke,									
automobile emission)?									
What indicators can be used to	The amount of increased	Measurement/observatio	A representative						
measure baseline conditions	dust; community	n/ inquiry	of						
(<i>road dust</i>) and impacts (<i>dust</i>)	complaint.								
<u>from the project</u>)									
Where will you find data for	The monitoring station of	Request information	A representative						
each indicator? (<i>road dust</i> and	the Pollution Control Dpt.	from related	of						
dust from the project)	(If exist)	organization.							
What methods will be used to	Compare dust	Collect current data and	A representative						
assess baseline conditions and	concentrations before and	during operation.	of						
predicted impacts?	after the project start.								
How will you prioritize the	HIA team and stakeholders	Members of HIA team	A representative						
research questions and/or	set up the criteria.	and stakeholders vote for	of						
indicators?		each criteria.							
How will you determine which	Issue in concern of the	HIA team specify the	A representative						
ones will be included in the	community or consistent	criteria.	of						
final scope of the study?	with the criteria.								

<u>Summary</u> Team's opinion air pollution – <u>dust, smoke, emission</u>.....studynot study

In case of study, the method in column 3 will be followed by assigned person in column 4.

Tool #3									
Scoping									
Example 2 Health outcome /Determinant: Land forming/construction cause traffic jam.									
Research question	Impact Research	Methods	Responsible						
	Questions		party						
What are the existing/baseline	There are many large plants	Survey for number of	Local						
conditions related to the health	and offices in the	establishment, house,	administration						
determinants? (Traffic)	community; large	and automobile in the	officers.						
	community; most of the	community.							
	residents have cars; there are								
	public transportation.								
How will the project, plan, or	Number of automobile	Estimate the number of	A representative						
policy impact baseline	increase.	automobile after the	of						
(<i>Traffic</i>) conditions?		project is operated.							
What indicators can be used to	Number of automobile, the	Count and inquire for	A representative						
measure baseline conditions	opinion of people in	number of	of						
(<u>number of automobile</u>) and	community.	automobile in the							
impacts (Traffic)		community.							
Where will you find data for	Collect and estimate	Count the number of	A representative						
each indicator? (Number of	according to the information	automobile at some	of						
automobile before and after	of the project.	point of time and area							
<u>the project</u>)		that may be affected							
		by the project or							
		inquire people in the							
		community							
What methods will be used to	Compare the number of	Collect data at the	A representative						
assess baseline conditions and	automobile between before	present and when the	of						
predict impacts?	and after starting of the	project runs.							
	project.								
How will you prioritize the	HIA team and stakeholders	Members of HIA team	A representative						
research questions and/or	set up the criteria.	and stakeholders vote	of						
indicators?		for each criteria.							
How will you determine which	Issue in concern of the	HIA team specify the							
ones will be included in the	community or consistent	criteria.							
final Scope of the study?	with the criteria.								

Summary Team's opinion on Land forming/construction cause traffic jamstudynot study

2.3 Health Risk Assessment

It is an analysis to identify the expected health impact arise from the project/plan/policy for both negative and positive; short and long term; the severity in construction and operation phases; population at risk or disadvantaged groups according to the scoping. There are steps as follows.

2.3.1 Analysis data of the project/plan/policy by reviewing the detail of the project thoroughly. This should cover at least production process, type/size/number of the machine, type and quantity of chemicals, raw materials, products and waste from the operation, including the control measure and the management during the construction and operation phase which may impact health and/or health determinants of the community and workers.

2.3.2 Community profiling and baseline information. Collect the current information and data which related to the activities of the project/plan/policy in order to study the impact. For example:

- Geographic condition

 Prevalence rates of communicable diseases and chronic diseases, especially those related to the pollutions arise from the project.

- Tendency of health problem
- Knowledge, practice and attitude concerning health.
- Water resources and adequacy.
- The level of environmental pollution.
- Community situation and condition.
- Social problems e.g. drug, crime.
- Health and social services.
- Literate and education level.
- Employ and un-employ rate.
- Main industry and its important.
- Community's concern and expectation from the project.

The data in this step could be secondary data from the government sources and local units e.g. Ministry of public health, provincial public health office and local administration office. It should cover at least 4 categories, i.e. physical resources, biological resources, human use values and quality of life values. Table 3 present such organizations and Tool #4 (Appendix B Baseline community questionnaire) could be used to collect the data. There may be many sources and method to obtain primary data, e.g. focus group, interview using Tool #5 (Appendix B: Personal information questionnaire).

Category of data	Resource
1 Physical resources:	
 Geographic characteristic 	– Department of Mineral Resources, Ministry of
– Geological characteristic	Industry
	 From the Maps Command, Thailand
	– Land Development Dpt., Ministry of Agriculture and
	Co-operation
 Weather and meteorology 	 Weather station nearby the project
 Air quality 	 Air quality data from the nearby station.
	– Air quality standards issued by the Office of National
	Environmental Board. (Volume 10, 2538 B.E.)
	 Air quality standards issued by the Office of National
	Environmental Board. (Volume 24, 2547 B.E.)
	 Air quality standards issued by the Office of National
	Environmental Board. (Volume 28, 2550 B.E.)
	 Air quality standards issued by the Office of National
	Environmental Board. (Volume 33, 2552 B.E.)
 Noise level 	 Pollution Control Dpt.
 Water quality 	 Standard of water quality in surface water, type 4 as
	the Office of National Environmental Board. Volume
	8, 2537 B.E.
	 Standard of drinking water in rural as The Board of
	Water supply throughout the Kingdom.
	 The environmental quality follow-up report of the local
	administration unit.
2 Biological resources:	
- Forest	- Report and statistic of the forest situation in Thailand.
3 Human use values:	X 11 1 . 1
– Land use	- Local development plan
The man enteries	- City plan
- Transportation	- Bureau of Highway Safety, Dpt. of Highway
– Public utilities	- The Provincial Electricity Authority
	- waterworks
	The appual report of municipal services in provincial level
- Solid waste and sewage	- i ne annual report of municipal governing authority.
management	
4 Quality of file values	Education development n ¹ -
- Economic and social situation	- Education development plan

Table 3 Resources, human use and quality of life values.

Category of data	Resource
	 Provincial education management accordingly the
	National Education Act, 2542 B.E.
	- Education reform structure of the Ministry of
	Education
– Life style, tradition, custom	 The annual report of the province
and culture	– Dpt .of factory.
– Occupational health and safety	– Office of compensation fund, Ministry of Labour.
	 Top 5 statistics of injury by the office of provincial
	public health.
	 Safety at work Center statistics
	- Center of technical development in industrial area.
– Public health	 Civil Registration Section, Municipality Office
	 Provincial Public Health Office
	 Provincial hospital
	– Health station
 Aesthetics and tourism 	 Tourism statistics of the province.

Table 3 Resources, human use and quality of life values.

2.3.3 Collect qualitative and quantitative data. The necessary data and methods defined in the scoping step e.g. air, water and soil sampling to analysis for the contamination occurring due to the project.

2.3.4 Health risk analysis. Risk matric is the product of probability of the impact to occur and the consequence of the event.

1) Probability of the occurrence means the exposure to risk factors or health hazards relating to; frequency, duration, quantity of exposure; affected area; distribution and composition of population especially where the disadvantaged and high risk groups located, e.g. school, hospital. Health impact factors or health determinants may be divided into 2 groups, i.e. physical and social factors. For the physical factors, e.g. chemicals, and air pollutants, probability of the occurrence or exposure rating have rating criteria as shown in Table 4 and 5. The consequence for noise exposure present in Table 6 for workplace based on NIOSH recommendation and the notification of the National Environmental Board, volume 15, 2540 B.E.; and Table 7 for general environment based on Night Noise Guideline for Europe (WHO, 2009). Probability criteria for consideration of poor sanitation have 2 levels as shown in Table 8. While social factors e.g. wellbeing; sufficient of medical services, utilities; aesthetics, social problems, etc. has 4 levels as present in Table 9.

E	xposure level	Definition
1	Not exposure	Chemical concentration $\leq 10\%$ standard value
2	Low	Chemical concentration \leq 50% standard value
3	Moderate	Chemical concentration \leq 75% standard value
4	High	Chemical concentration $\leq 100\%$ standard value
5	Very high	Chemical concentration > 100% standard value

Table 4 Exposure 1	levels a	and its	definition
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Note: Standard values are in Appendix C, Table 27 for community and Appendix A, Table 19 for workplace. Source: Adapted from Air sampling instruments for evaluation of atmospheric contaminants, Beverly S. Cohen, Charles S. McCammon, Jr., Editors, 9th Edition, Kemper woods center, Cincinnati, Ohio. 2001.

Table 5 Exposure levels and its definition (Chemical concentration) for NO₂ in community.

E	xposure level	Definition
1	Not exposure	$\leq 10\%$ standard value
2	Low	\leq 50% standard value
3	Moderate	Frequently \leq 50% standard value or 50 – 100% sometime, not so often
4	High	@ 100% standard value or $> 100\%$ but not so often.
5	Very high	> 100% standard value quite often

	Exposure	Definition	Health effects
1	Low	\leq 80 dB(A) hrs.	Low impact, may interfere conversation
2	Moderate	\leq 85 dB(A) hrs.	Moderate impact, annoy, interfere conversation, app 3-
			5% of the exposed may loss hearing.
3	High	\leq 90 dB(A) hrs.	High impact, annoy, interfere conversation, app 10-20%
			of the exposed person may loss hearing.
4	Very high	> 90 dB(A) hrs.	Very high impact, more than 20% of the exposed person
			may loss hearing.

Table 6 Noise exposure level and its consequence – workplace.

Source: Adapted from the notification of the National Environmental Board, volume 15, 2540 B.E, and NIOSH and OSHA standard.

 Table 7 Noise exposure level and its consequence – community.

	Exposure	Definition	Health effects
1	Low	< 50 dB(A) at night	No health effect, may little disturb or annoy
2	Moderate	\leq 70 dB(A) 24 hrs.	Moderate disturb or annoy
3	High	\leq 75 dB(A) 12 hrs.	Highly disturb
4	Very high	> 75 dB(A) 12 hrs.	May impact mental health and serious disturb.

Source: Adapted from the notification of the National Environmental Board, volume 15, 2540 B.E

 Table 8 Criteria for health impact of the poor sanitation

Probability	Definition
1 Low	Comply with the standard or have good sanitation management
2 High	Not comply with the standard or have poor sanitation management

Probability	Definition
1	No chance to occur
2	Possible: expected result comply with the standard because of having a reliable control measure; or have chance to occur but is not the statistical significant; or the prediction on the circumstance points out that the local authority can cope with the problem and according to the survey, socio-economics is not a concerned issue.
3	Probable, expected result is close to the standard; there is such the event occur before; there is some technical paper, research or evident supporting that its chance to occur is statistical significant; or the local authority cannot cope with the problem and according to the survey, socio-economics is an issue of concerned.
4	Definite, expected result exceeds the standard because of there is no control measure; the local authority cannot handle the problem and cannot manage for other to do so; according to the survey, socio-economics is a highly concerned issue.

	Table	9	Criteria	for	health	impact	of	social	factors
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2) Severity of the consequence. For physical factors, severity level has been divided in to 5 levels as present in Table 10 and 11. The consequence of the social factors are divided in to 4 levels as in Table 12. For sanitation problems, the criteria for health impact of physical and social factors in Table 11 and Table 12 respectively.

Fable 10 Criteria for health	impact of	physical factors -	workplace
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Health effect	Definition
1	 No known permanent health effect
2	 Mild health effect, symptom disappear after discontinue exposure. No medical treatment needs for recovery. Usually no sick leave.
3	 Severe reversible health effect. Medical treatment required for recovery. Usually have sick leave and lost time.
4	 Irreversible health effect; not treatable. New life style required to adapt to disability.
5	 Life threatening or totally disabling injury or illness.

Source: Air sampling instruments for evaluation of atmospheric contaminants, Beverly S. Cohen, Charles S.

McCammon, Jr., Editors, 9th Edition, Kemper woods center, Cincinnati, Ohio. 2001.

Health effect	Definition
1	 No known health effect
2	 Mild health effect for people with respiratory problem.
3	 Vulnerable or sensitive person e.g. child, elder, people with respiratory disease may have health problem if inhale a lot of air such as while exercise.
4	 Vulnerable or sensitive person may have health problem even inhale the air at normal rate
5	 Severe health effect for vulnerable or sensitive person

Table 11 Criteria for health impact of NO2 – community.

Table 12 Criteria for health impact of social factor

Health impact	Definition
1	 No impact or the change is in normal or acceptable level
2	– Both negative and positive impact, little effect on quality, wellbeing and
	aesthetics; impact on small area.
3	– Moderate positive impact: mental health or wellbeing get better significantly
	and/or symptom or incident rate of illness is decrease.
	– Moderate negative impact: aggravate the existing illness, temporally ill,
	disturb aesthetics in long run.
	– Annoy or decrease quality of life; may have direct impact on mental health or
	health determinant or impact broaden area.
4	– Positive impact: prevention or be long-lived; reduce acute or chronic disease;
	increase wellbeing and better mental health significantly.
	– Negative impact: lead to death, acute and chronic disease or mental health
	problem.
	– Effect both on mental and physical health directly or on health determinant
	and wellbeing. The effect maybe temporary or permanent.
	- The impact occur in broad area and cannot be controlled or remedied.

Source: Adapted from Good Practice Guidance on Health Impact Assessment, International Council on Mining and Metals 2554

3) Risk Characterization. Risk matrix of the two factors, exposure or opportunity and consequence or impact, for physical, social and sanitation are presented in Table 13-15 respectively, and Table 16 presents risk level and guide for control measure.

Exposure/opportunity	Severity of the consequence					
Exposure/opportunity	1	2	3	4	5	
1	1	2	3	4	5	
1	(Low)	(Low)	(Low)	(Moderate)	(Moderate)	
2	2	3	4	8	10	
<i>L</i>	(Low)	(Low)	(Moderate)	(Moderate)	(High)	
2	3	6	9	12	15	
5	(Low)	(Moderate)	(Moderate)	(High)	(High)	
Λ	4	8	12	16	20	
4	(Moderate)	(Moderate)	(High)	(High)	(Very High)	
5	5	10	15	20	25	
5	(Moderate)	(High)	(High)	(Very High	(Very High	

Table 13 Health risk matrix for physical agent.

Table 14 Health risk matrix for social factor

Exposure/opportunity	Severity of the consequence					
Exposure/opportunity	1	2	3	4		
1	1	2	3	4		
1	(Low)	(Low)	(Moderate)	(Moderate)		
2	2	4	6	8		
2	(ต่ำ)	(Moderate)	(High))	(High)		
2	3	6	9	12		
3	(Moderate)	(High)	(High	(Very high)		
4	4	8	12	16		
4	(Moderate)	(High))	(Very high)	(Very high)		

 Table 15 Health Risk Matrix for sanitation

Exposure/opportunity	Severity of the consequence					
Exposure/opportunity	1	2	3	4	5	
1	1	2	3	4	5	
1	(Low)	(Low)	(Moderate)	(Moderate)	(High)	
2	2	4	б	8	10	
2	(Low)	(Moderate)	(High)	(Very High)	(Very High)	

	ระดับความเสี่ยง	Control moogunog	
Physical	Social	Sanitaion	Control measures
1-3 Low	1-2 Low	1-2 Low	Acceptable. No need for control measure
4-9 Moderate)	3-4 Moderate	3-4 Moderate	Monitoring program should e implement.
10-16 High	5-9 High	5-6 High	Un-acceptable. Risk management should be conducted as soon as possible.
17-25 (Very high)	10-16 Very High	8-10 Very High	Un-acceptable. Risk control should be conducted immediately.

Table 16 Risk Level and control measures for social sanitation factor

Tool #6 Health impact assessment. The following is an example of health impact assessment conducted in the Enamel Factory for construction and operation phases for both communities and workers.

Tool #6								
Health impact assessment								
Example: H	lealth impact as	ssessment condu	icted - Enamel Factory: Construction p	hase				
			Health impacts	Health Ri	sk Matrix			
Health Hazards	Activities	Risk groups	(+) positive (-) negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project	
Effect on co	mmunity	L	•	l		1		
1. Dust (Air	Land forming	Nearby	Physical Health	(2)	(1)	(2)	- During the land forming,	
pollutant)	and road	communities	(-) eye/skin/nose irritation, cough,	Estimate dust	No known	Low	do not work on whole land	
	transportation		sneeze, respiratory tract disease e.g. flu,	concentrations arise from	health		surface at the same time.	
			allergy, etc.	the activities and compare	effect.		-Spray water to cover land	
			Mental Health:	with the standard and			surface at least 2 times a	
			(-) Be irritate or annoy due to dust	effect on nearby			day and may be more if	
			covers all over things in house, clean	communities.			construction site is close to	
			up must be done more often.				community.	
							- Cover the things and	
							construction materials on	
							the truck while transport	
							in/out the site.	
							- Limit speed of vehicle	
							in/out the site.	
2.Noise	Working with	Nearby	Physical health:	(2)	(2)	(4)	- Build a wall between	
	instrument or	communities	(-) 85 dBA is the noise level that may	Estimate or measure noise	Prolong	Moderate	community and	

Tool #6								
Health impact assessment								
Example: H	lealth impact as	ssessment condu	icted - Enamel Factory: Construction p	hase				
			Health impacts	Health Risk Matrix				
Health Hazards	Activities	Risk groups	(+) positive (-) negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project	
	machine,		cause health effects (WHO) such as	level on site and compare	exposure to		construction site.	
	vehicles e.g.		irregular heartbeat, high blood pressure,	with the standard.	noise may be		- Specific working hour for	
	truck, tractor,		convulsion, Respiratory rate change,		annoy		those cause \geq 85 dBA and	
	backhoe, etc.		exertion, sleepless, hearing loss.				provide hearing protector to	
			Mental health:				all workers whose average	
			(-) Be annoy, be irritated, loss temper,				exposure > 90 dBA in 8 hrs.	
			Lose concentration, stress.					
3.Obstruct	Construction	Travelers and	Physical health:	(2)	(2)	(4)	-Management plan for	
the traffic/	material and	community	(-) Injury, death, property damage;	Estimate the increasing of	In case of	Moderate	traffic during the	
road	worker		small shops set up around the project	the traffic and sufficiency	road accident,		construction phase.	
accident	transportation		site to service the workers may take	of the road including the	the result may		- Arrange for persons to	
	may cause		public space e.g. road surface.	effect of the obstruction.	be injury and		control or facilitate the	
	traffic jam.				inconvenienc		traffic at all time.	
					e for the road		-Put up signs or warning	
					users.		light easily seen in day and	
							night time by the road users	

Tool #6								
Health impact assessment								
Example: H	Example: Health impact assessment conducted - Enamel Factory: Construction phase							
			Health impacts	Health Ris	sk Matrix			
Health	Activities	Risk groups	(+) positive	Exp. level /	Impact	Risk	Mitigation measure by	
Hazards			(-) negative	opportunity	level	level	the project	
4. Sanitation,	Approximate	Nearby	Physical Health:	(1)/(1)	(1)/(2)	(1)/(2)	- Provide enough bags to	
waste,	80 kg/day of	community	(-) Communicable disease which has	Estimate the amount of	The quantity	Low	collect the garbage and	
garbage and	garbage from		rodent and/or cockroach that come for	garbage from workers'	of the		contact the municipality to	
construction	the workers'		the garbage are the carriers.	living and construction (90	garbage is		take them for disposal.	
	eating and		Mental health:	kg/day; 100 workers).	not too			
	consuming		(-) Be irritated due to the smell of the	The project has arranged	much the			
	and		garbage.	for the municipality to	municipality			
	construction		Social impact:	collect the garbage every	can handle			
	waste.		(-) Increase the burden on the local	day.	it.			
			administrative office to manage the					
			garbage.					
5 Waste	- Dirty water	Nearby	Physical health:	(1)	(1)	(1)	- Do not allow washing	
water	from the	community	(-) if the water source is contaminated,	Estimate quantity of	There is no	Low	equipment, tools, and	
water	construction	and people	no one can use it, and then water source	waste water from the	water source		machine and/or drain	
	activities and	who use those	may turn to be place of dangerous or	activities on the site.	around the		contaminated water, used	
	from the	water sources	disease carrier animals.	(usually waste water is	site.		engine oil, and other	
	workers'			approximately 80% of			contaminated into water	
	living.			used water)			source and the public	
			Tool	#6				
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			Health impact	assessment				
Example: H	lealth impact as	ssessment condu	acted - Enamel Factory: Construction	phase				
			Health impacts	Health R				
Health Hazards	Activities	Risk groups	(+) positive	Exp. level /	Impact	Risk	Mitigation measure by the project	
			(-) negative	opportunity	level	level		
	-Trenching						drainage.	
	may cause						-Do not dispose garbage or	
	surface water						construction waste into	
	contamination						natural water source.	
6.Mental	Dust, noise,	Nearby	Mental health:	(2)	(2)	(4)	- publicize construction plan	
health	traffic jam	communities	(-) Stress, worry, sleepless.	Compile the worried	The	Moderate	and meet with the community	
problem due	generated	and the road		issues in all aspects of	community		leader, local administrative	
to worry	from the	users.		the people in	worry about		officers, police station, and	
about the	construction			community.	the		other government service	
environment	could bother				environmental		units in order to explain about	
al impact,	and irritate.				impact,		the construction plan and	
inconvenien					inconvenience		mitigation measures, and ask	
ce, pollution					pollution and		for cooperation.	
and crime.					crime		- Set up a team to response	
							for the request and inquiry	
							of the community. The team	
							will visit the community	
							periodically.	

			Tool #	46			
			Health impact a	assessment			
Example: H	ealth impact as	sessment condu	icted - Enamel Factory: Construction pl	hase			
			Health impacts	Health Ri			
Health	Activities	Risk groups	(+) positive	Exp. level /	Impact	Risk	Mitigation measure by
Hazards			(-) negative	opportunity	level	level	the project
7	A lot of	Shopkeepers	(+) Income increase.	(3)	(1)	(3)	
Economics	worker move	who sell		Certainly	The project is	Moderate	
	in the area,	consumer			medium size.		
	business is	product in the					
	good	community					-
	especially the	around the					
	consumer	project.					
	products store.						
8 Social	Workers and	Teenagers,	(-) Conflict between community and	(2)	(3)	(6)	
	teenagers in the	communities,	construction workers.	The number of worker	Short term	High	
	area assemble	workers.	(-)assemble for unlawful purposes	and teenager in the	impact		-
	for unlawful		among workers and teenagers.	project and community			
	purposes						
A. <u>Imp</u>	act on construc	tion workers.				I	
1.Hazards	Unsafe	Construction	Physical health	(2)/(2)	(2)/(2)	(4)/(4)	- Provide suitable PPE and
and accident	working	workers.	(-) Occupational injury, illness, falls,	Consider risk of	Consider	Moderate	supervise the workers to
in workplace.	environment		disability, death.	construction workers.	number and		use them.

Tool #6											
Health impact assessment											
Example: H	ealth impact as	sessment condu	acted - Enamel Factory: Construction p	hase							
			Health impacts	Health R							
Health Hazards	Activities	Risk groups	(+) positive (-) negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project				
	and conditions e.g. welding, X-ray while inspection the internal void of ducts.		<u>Mental health.</u> (-) Occupational stress due to unsafe working condition.		rate of occupational injury, lose work day.		- Arrange occupational health and safety training for all the workers.				
2.Dust from construction	Trenching, construction material transportatio n	Construction workers	 <u>Physical health</u> (-) eye/skin/nose irritation, cough, sneeze, respiratory tract disease e.g. flu, allergy, etc. <u>Mental Health:</u> (-) Be irritated or annoy due to prolong exposure to dust. 	(2)/(2) The construction phase takes only 9 months and there are mitigation measures to reduce dust generation.	(1) /(3) No impact on increment of the incident rate of respiratory tract of the workers and no lose work day.	(2)/(6) Low /High	 Spray water at least 2 times /day Cover the things and construction materials on the truck while transport in/out the site. Supervision on the use of PPE of the workers. 				

	Tool #6										
			Health impact a	assessment							
Example: Health impact assessment conducted - Enamel Factory: Construction phase											
Health Hazards Activities		Risk groups	Health impacts	Health Ris	sk Matrix						
	Activities		(+) positive	Exp. level /	Impact	Risk	Mitigation measure by				
			(-) negative	opportunity	level level		the project				
3.Construction	Equipment,	Workers who	Physical health	(2)/(2)	(2)/(3)	(4)/(6)	- Limit working hour for				
noise	machine may	work with	(-) Irregular heartbeats, inspiration rate	Consider: Time period	Consider:	Moderat	worker who exposing to				
	generate <u>></u> 80	those	changes, high blood pressure, exhaust,	that noise exceed 80 dBA	Severity of	e/High	noise exceed 85 dBA not				
	dBA at 15	equipment and	sleeplessness, temporally or permanent	and control measure.	health effect		more than 8 hrs./day and				
	meter away	machine.	hearing loss,		(Column 4)		provide proper hearing				
	from the <u>Mental health</u>						protectors.				
	sources.		(-) Be irritated, annoy, stress.								

	Tool #6									
	Health impact assessment									
Example: Health	Example: Health impact assessment conducted - Enamel Factory: Operation phase									
			Health impacts	Health	risk matrix					
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
A. Impact of	n community									
1. Worry about	The amount of	People live close	Mental health	(2)	(1)	(2)	- Set up public relation			
flammable	chemicals used	to the factory.	(-) Worry, stress, fear,	Consider the results of	Consider	Moderate	team to visit and meet			
chemicals used	and stored in the		insomnia.	community survey	existing control		with the community to			
in the factor	factory is quite a			asking about	measures e.g.		give information and			
which may cause	lot. Although the			confidence on the	emergency plan,		answer the question that			
explosion and	storage method			factory safety system	attitude of the		they may have			
fire.	has been			of the residents,	people live		concerning safety			
	complied with			establishments, etc.	nearby the		system of the chemical			
	the standards.				factory.		storage and any issue.			
							- Listen to their opinion.			
2. Hazards due to	LPG leaking could	-communities	Physical health.	(2)	(2)	(4)	- The design of the			
leakage of LPG	occur due to piping	nearby the	(-) Prolong expose to LPG	Estimate probability of	Consider the	Moderate	storage and use of			
and fire.	system damage	factory.	cause CNS depression and at	disaster to occur. (1 time	impact of heat		chemicals is complied			
	and heat source is		very high concentration may	in 1000 year)	radiance in case		with the international			
	available at that		cause unconscious and		that the leakage		standard in all step.			
	time.		death.		cause Jet Fire		- There are work			

	Tool #6									
	Health impact assessment									
Example: Health impact assessment conducted - Enamel Factory: Operation phase										
			Health impacts	Health	ı risk matrix					
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
					with the energy		procedures.			
					of 12.5 and 4		-There is emergency			
					kW/m ² and		plan and drill at least			
					control measure		once a year.			
					including		- There is an insurance			
					leakage		covered life and			
					detector.		property if the accident			
							or major hazard occur			
							due to the operation of			
							the factory.			
3 Chemicals and	Storage and	Worker	(-) Health effect on CNS.	(1)	(2)	(2)	There is a place to keep			
hazardous waste.	disposal of	/communities		There is some distance	Chemical	Low	empty vessels and waste			
	empty chemical			between community	concentrations		far from the fence of the			
	vessels and			and factory.	in the		factory and they will be			
	waste.				community are		disposed by the certified			
					very low.		3 rd party.			

	Tool #6									
			Health impact	assessment						
Example: Health	impact assessmen	t conducted - Er	namel Factory: Operation pha	ise						
			Health impacts	Health	Health risk matrix					
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
4 Communication	Heavy traffic on	Communities	(-) Stress due to traffic jam.	(2)	(1)	(2)	Define the time for			
and transportation.	the road due to			Consider the number of	Not affect the	Moderate	goods, chemicals and			
	many vehicles of			vehicles in and out of	rush hour.		raw materials transport			
	the factory e.g.			the factory.			trucks to enter the			
	employee buses						factory.			
	and goods,									
	chemicals and									
	raw materials									
	transport trucks.									
	Road accident									
	increase									
5 Socio-	There are many	Community	(+) Some business e.g.	(1)	(2)	(2)	-			
economics	people involve		apartment for rent,	There is a canteen in the	People in the	Moderate				
	with the factory		convenient store has more	factory selling cheap food.	community have					
	business e.g.		customers; less unemployed,		better life and					
	employee and		thus money flow better.		employed.					
	customer, etc.									

Tool #6										
	Health impact assessment									
Example: Health impact assessment conducted - Enamel Factory: Operation phase										
			Health impacts	Health impacts Health risk matrix						
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
	There are 3 shifts	Community	(-) Drug an crime problem	(1)	(3)	(3)	-			
	work.		could occur because	Number of worker	Serious social	Moderate				
			workers, truck drivers and	move in the area.	problems.					
			teenagers assemble for							
			unlawful purposes around							
			the factory. Then other							
			social problems could arise							
			e.g. prostitute.							
B Impact on the wo	<u>orkers</u>									
1. Accident in	Unsafe conditions	Workers	Physical Health	(2)	(3)	(6)	- Provide suitable PPE			
workplace.	and environment		(-) injure, ill, disability,	Consider workplace	Consider severity	High	and supervise the			
			death.	condition and	of injury or		workers to use them.			
			<u>Mental health</u>	environment; statistic	death; number of		- Preparedness for			
			(-) Stress due to workplace	of occupational injury	sick leave days or		emergency e.g. have			
			condition and environment.	and illness.	absence from		transportation available			
					work.		for taking injured			
							worker to hospital.			

	Tool #6									
Health impact assessment										
Example: Health impact assessment conducted - Enamel Factory: Operation phase										
			Health impacts	Health	risk matrix					
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
2. Volatile	Production line,	Workers	(-) Effect on CNS and may	(5)	(5)	(25)	-Use benzene free			
organic	chemical		cause cancer and teratogenic	Consider VOC	Effect on CNS	Very	solvent.			
compound, VOC.	transshipment,		effect.	concentration (result of	and Leukemia	high				
	waste.			air monitoring,	(benzene)					
				Appendix A)						
3 Heavy metal	Production line,	Workers	(-) Effect on PNS and may	(1)	(1)	(1)	- Use lead and			
	chemical		cause cancer, teratogenic	Consider quantity of use	No lead and	Low	cadmium free			
	transshipment,		effect and hematopoietic	and substituted	cadmium in raw		compounds and			
	waste.		system, etc.	substances.	materials or		chemicals.			
					chemicals					
3. Hazard due	Leakage may	Workers and	Physical health	(2)	(1)	(2)	- Inspect and			
to leakage of	occur during	community	(-) Prolong expose to LPG	Consider leaking and	Consider the	Low	maintenance gas			
LPG and/or	transshipment		cause CNS depression and at	starting fire opportunity	severity of the		piping system			
flammable	and there is		very high concentration may	of the piping system if it	impact in case of		regularly.			
chemicals.	source of heat in		cause unconscious and death.	is acceptable. Is there	accident and how		- Have emergency plan			
	such area, then		- In case of fire, victim may	effective monitoring and	fast the emergency		and drill at least once			
	fire or explosion		be burned and if severe could	maintenance plan and	response could be.		a year.			

	Tool #6									
	Health impact assessment									
Example: Health impact assessment conducted - Enamel Factory: Operation phase										
			Health impacts	Health	risk matrix					
Health Hazard	Activities	Risk groups	(+) Positive (-) Negative	Exp. level / opportunity	Impact level	Risk level	Mitigation measure by the project			
	could occur.		be death.	procedure. Is there an emergency plan.						
5. Ergonomics	Lift or move goods	Workers	(-) Muscle pain, low back	(2)	(2)	(4)	Use hand-lift and			
	during filling,		paint	Consider weight of	Muscle pain.	Moderate	appropriate work			
	packing, and put			goods, frequency and			station.			
	on the pallet.			speed of work.						

Health impact assessment described above is based on normal operation 0f the project/factory. In case of emergency e.g. chemical spill, fire, explosion or others, the project owner must have emergency plan which covers preparation, response and remedial plan.

2.3.5 Prioritization of the impacts.

After risk characterization was done, the prioritization of the hazards and heath determinants should be proceeded. The one with the highest risk will be in the first order and the lower risk is next. Tool #7 can be used to collect information necessary to define the priority of the hazards and prevention and control measures including monitoring.

			To Prioritize the	ool #7 e health impacts						
Exa	Example:									
R	lisk rating									
(+) (-)	Positive Negative	Determinant	Risk population	Health impacts						
Co	nstruction p	hase								
(-)	6 High	Social	Community & workers	- Conflict between community and construction workers assemble for unlawful purposes among workers and teenagers.						
(-)	4 Moderate	Obstruct the traffic/ road accident	Travelers and nearby communities	 Injury, death, property damage due to the road transportation of the construction materials and workers in and out the site. small shops are set up around the project to service the workers may take public space e.g. road surface. 						
(-)	4 Moderate	Noise	Nearby communities	-85 dBA is the noise level that may cause health effects such as irregular heartbeat, high blood pressure, convulsion, Respiratory rate change, pant, sleepless, hearing loss - Annoy, disturb, lose concentration, stress						
(-)	1 Low	Garbage	Community & workers	- Communicable disease which has rodent and/or cockroach that come for the garbage are the carriers.						
(-)	1 Low	Garbage	Community & workers	- Be irritate due to the smell of the garbage						
Op	eration pha	se								
(-)	25 Very high	VOCs	Worker	Effect on CNS and may cause cancer and teratogenic effect.						
(+)	2 Low	Social & economics	Community	- Some business e.g. apartment for rent, convenient store has more customers; less unemployed, thus money flow better						

HIA mention above is in normal operation of the project. In case of emergency e.g. chemical spill, fire, explosion or others, the project shall have an emergency plan according to the relevance law. The plan shall cover preparation, response and remedy in any case. Compiling the recommendation. After health impact assessment has been done, the result.

2.3.6 Compiling the recommendation. After health impact assessment has been done, the result and recommendation of the HIA team should be presented to public in order to have the stakeholders' involvement. Any comment from the hearing should be considered and prepared for the report to propose to the decision maker.

2.4 Report

The content of the report should be:

2.4.1 Introduction. Describe the important and rationale of the health impact study, study method and criteria.

2.4.2 Description of the project. Describe about the site selection; production process; air, water and soil pollution control measures; chemicals selection; raw material, goods, waste transportation; waste disposal, etc. and how community health impact has been considered based on those selection.

2.4.3 Current environmental situation. Describe the initial data of the community compiling by interview using the forms in App B; statistic of diseases and injury in the community especially those related to chemicals and pollutions from the project (may obtain from provincial health office).

2.4.4 Health and environmental impact may arise from the project. The results of health impact study according to the steps of HIA are:

1) Screening for risk factors. Study the detail of the project in order to screen for chemicals, physical and biological hazards in construction and operation phases.

2) Screening for social and economic factors and others.

3) Scope area of study by the HIA team and stakeholders.

4) Risk appraisal and prioritization; and summary of the prevention measures and mitigation should or need to be developed.

2.4.5 Mitigation and prevention. Describe the mitigation and prevention for environmental and health impacts including compensation for any damage.

2.4.6 Environmental monitoring and health surveillance.

2.4.7 Conclusion. Conclude health impact factor, mitigation and prevention and monitoring measures.

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Chapter 3 Mitigation and prevention & Monitoring and evaluation

3.1 Environmental monitoring and health surveillance

Once health risk has been assessed the HIA team has to brainstorm or use any method to propose and select the appropriate mitigation and prevention measures. The best control measure is that control at source or engineering control which should be considered to implement in design state. The unacceptable risk as defined in Table 16 must have mitigation and prevention measures which are defined and developed by the team (project owner or his representative should be in the HIA team) in accordance with the guideline in Appendix D using Tool #8.

3.2 Monitoring and evaluation

The plan for monitoring, evaluation and report of the results of the monitoring and health impact evaluation must be set up. The indicators for diseases or illness related to the project e.g. cancer due to the chronic exposure to carcinogen must be defined and monitored using Tool #8. See an example below. The stakeholder and community representatives should participate in this process, especially in the survey and observation to see if the proposed mitigation and prevention measures have be done or not. The results of the monitoring should be compared with the initial data to evaluate the impact in each period. The additional control measures may be needed.

After public hearing, when the project owner and stakeholders agree with the proposed or the correction (if there is any disagree) has been done, the decision-maker approve and give the permission to run the project, plan, or policy. The measures are deployed and follow up and evaluation periodically as the following description.

Tool #8 will assist the team to summarize mitigation and prevention measures including monitoring and evaluation process systemically.

	Tool #8										
	Control, prevention and monitoring measures										
Example: Heath determinants and prevention measures proposed by the HIA team											
Heath	Risk level	Control measure proposed by the project	Additional measures	Monitoring and Evaluation							
determinants			by HIA team	8							
Construction phase – impact on community											
1 Social	(-) 6	- Public relation and communication about	Arrange for the	- Observe and follow-up the work							
	high	construction plan; meet with the communities	policeman to patrol in	periodically throughout the construction.							
		leaders; issue rules to control and supervision the	the area periodically.								
		workers to prevent the conflict with the community.									
2. Noise	(-)4	- Construct sound barrier around the construction		- Observe and follow-up the work							
	Moderate	area;		periodically throughout the construction.							
		- Limit the working hour in the area with noisy									
		work (>85 dBA) to not exceed 8 hrs/day and	-								
		provide suitable hearing protector to all workers in									
		such area.									
3. Road	(-)4	- Set plan for transportation related to the		- Observe and follow-up the work							
obstruction/	Moderate	construction to reduce the traffic jam;		periodically throughout the construction.							
Road accident		- Provide a traffic controllers at all time.									
		- Have clear and easy to see traffic signs or marks	-								
		both day and night at the distance of 100 meters or									
		as the local officer specifies.									
3. Road obstruction/ Road accident	(-)4 Moderate	 work (>85 dBA) to not exceed 8 hrs/day and provide suitable hearing protector to all workers in such area. Set plan for transportation related to the construction to reduce the traffic jam; Provide a traffic controllers at all time. Have clear and easy to see traffic signs or marks both day and night at the distance of 100 meters or as the local officer specifies. 	- -	- Observe and follow-up the work periodically throughout the construction							

	Tool #8							
	Control, prevention and monitoring measures							
Example: Heat	h determina	nts and prevention measures proposed by the HIA (team					
Heath determinants	Risk level	Control measure proposed by the project Additional measure by HIA team		Monitoring and Evaluation				
4. Mental	(-)3	- Public relation about the construction plan and		- Observe and follow-up the work and				
health, worry	Moderate	meet with the local authority, communities leaders,		inquire people around the project				
due to		local police, etc. to clarify about the construction		periodically throughout the construction.				
environmental		plan, methods, and potential impact in order to						
impact		share and consult about the mitigation measures	-					
problems.		and cooperation.						
		- Set up public relation team to meet and visit the						
		nearby communities to monitor and receive the						
		complaint.						
5. Economics	(+)3	Income increase, the money flows better.	Encourage and promote	- Observe and follow-up the work				
	Moderate		the sanitation	periodically throughout the construction.				
			management in that					
			area.					
6. Dust	(-)2	- During the land forming, do not work on whole		- Observe and follow-up the work				
	Low	land surface at the same time.		periodically throughout the construction.				
		-Spray water to cover land surface at least 2 times a	-					
		day and may be more if close to community.						

Tool #8								
Control, prevention and monitoring measures								
Example: Heat	h determina	nts and prevention measures proposed by the HIA t	eam					
Heath determinants	Risk level	Control measure proposed by the project	Additional measures by HIA team	Monitoring and Evaluation				
		 Cover things and construction materials on the truck while transport in/out the site. Limit speed of vehicle in/out the site. 						
7. Env. Health: construction waste and garbage	(-)2 Low	- Provide enough bags to collect the garbage and contact the municipality to take them for disposal.	-	- Observe and follow-up the work periodically throughout the construction.				
8. Waste water and quality of water	(-)1 Low	 Do not allow washing equipment, tools, and machine and/or drain contaminated water, used engine oil, and other contaminated into water source and the public drainage. Do not dispose garbage or construction waste into natural water source. 	-	 Observe and follow-up the work periodically throughout the construction. Take water sample for analysis periodically. 				
Construction p	hase- impac	t on workers		·				
1.Hazards and occupational accident	(-)4 Moderate	- Comply with safety law e.g. provide suitable PPEs to all workers and make sure that they use them at all time while working.	-	There is a safety officer in the construction site to do safety supervision, inspection and training.				

Tool #8								
	Control, prevention and monitoring measures							
Example: Heat	h determina	nts and prevention measures proposed by the HIA	team					
Heath determinants	Risk level	Control measure proposed by the project	Additional measures by HIA team	Monitoring and Evaluation				
		- Arrange training about occupational health and safety for the contractors' and sub-contractors' workers.						
2 Construction	(-)3	- Limit working hour for worker who exposing to	- Post the warning signs	Observe and follow-up the work				
Noise	Moderate	noise exceed 85 dBA not more than 8 hrs./day and	to remind the use of	periodically throughout the construction.				
		provide proper hearing protectors.	hearing protectors where	Measure noise level in workplace				
			the noise level exceeds					
			90 dBA.					
			- Provide hearing					
			protectors to all workers					
			who need them.					
3.Dust	(-)2	Spray water at least 2 time /day		- Observe and follow-up the work				
	Low	- Cover things and construction materials on the		periodically throughout the construction.				
		truck while transport in/out the site.						
		- Supervision on the use of PPE of the workers.	-					

	Tool #8						
Control, prevention and monitoring measures							
Example: Heat	h determina	nts and prevention measures proposed by the HIA t	eam				
Heath	Heath Additional measures Risk level Control measure proposed by the project Additional measures						
determinants			by HIA team	_			
Operation phas	se-impact on	community					
1.Health	(-)4	- Design the storage and the use of chemicals to	- Install LPG detectors	- Make sure that it is installed and			
hazard due to	Moderate	complied with the international standard in all step.	in the storage area.	complied with the standard.			
LPG leakage		- Establish work procedures.					
		- Have emergency plan and drill at least once a year.					
		- Have an insurance covered life and property if the					
		accident or major hazard occur due to the					
		operation of the factory					
2.Fire and	(-)2	- Set up public relation team to visit and meet with		- Periodically oversee the operation			
explosion	Moderate	the community to give information and answer the		plan of the factory.			
hazards due to		question that they may have concerning safety					
chemicals used		system of the chemical storage and any issue.					
in the project		- Listen to their opinion					
3 Chemicals	(-)2	There is a place to collect empty vessels and waste	- Measure VOCs	- Follow-up the work and oversee and			
and hazardous	Low	far from the fence factory and they will be	concentration around	analyze the incident and prevalence rate			
wastes		disposed by the certified 3 rd party.	the factory every 6	of related diseases, and then compare with			
			months.	the initial and annual data.			

Tool #8								
	Control, prevention and monitoring measures							
Example: Heat	th determina	nts and prevention measures proposed by the HIA	team					
Heath determinants	Risk level	Control measure proposed by the project	Monitoring and Evaluation					
Operation phase	se – impact o	on the workers		·				
1. VOCs	(-) 25	- Do not use chemical that is classified as human	- Ban the use of	- Follow-up the work and deployment of				
	Very high	carcinogen e.g. benzene.	benzene; if the	control measures				
		- Have medical surveillance program according to	composition of the	- Oversee and analyze the medical				
		the law for workers at risk.	chemical is unknown	examination reports of the risk groups.				
			the suspected	- Oversee and collect static of the local				
			chemicals must be	hospitals or and/or health centers about				
			tested for benzene.	occupational illness related to VOCs				
			- Follow-up the revision	- In case that benzene or other carcinogens				
			of carcinogen list at	are used, they must have control measures				
			least every 5 years.	to prevent the exposure of the workers				
				and contamination to the environment.				
2.Occupational	(-)6	- Provide suitable PPE and supervise the workers to	- Set up standard work	- Follow-up the work.				
accident	High	use them.	procedure.	- Oversee and analyze accident report and				
		- Preparedness for emergency e.g. have	- Have training course	statistic.				
		transportation available for taking injured worker	concerning hazards in					
		to hospital.	workplace for all new					

Tool #8								
Control, prevention and monitoring measures								
Example: Heat	h determina	nts and prevention measures proposed by the HIA t	team					
Heath	Bisk level Control measure proposed by the project Additional measures							
determinants	KISK IEVEI	Control measure proposed by the project	by HIA team	Monitoring and Evaluation				
			workers and periodic					
			refreshing course for					
			all workers.					
3. Hazardous	(-)2	- Inspect and maintenance gas piping system	- Install LPG detector in	- Oversee the medical check-up reports of				
gas from the	Moderate	regularly.	the storage area.	the risk groups.				
leakage of		- Have emergency plan and drill at least once a year.		- Statistics or frequency of sick and visit				
LPG and		- Cooperate with the local emergency response		the first aid room.				
flammable		team and police station to set up a fast response						
chemicals		team in case of emergency.						
4. Heavy	(-)1	- Use raw material without dangerous heavy metal	- Have 3 rd party to test	Monitor periodically to be sure that there				
metals	Low	e.g. lead, cadmium, etc.	the material to confirm.	is no dangerous heavy metal.				
		- Have medical surveillance program according to						
		the law for workers at risk.						

3.3 Risk communication

It is an information and opinion exchange process about risk and potential health hazards. The most accurate and corrected information is transferred to the target groups. Nevertheless, not only the information needed to transfer is considered, but also the target groups' needs, characteristic, and the different among them including presentation format and communication route. The target groups for HIA could be school (owner, students, teachers, etc.), people who live in nearby community, ones who lose or gain benefit from the project, etc. among these some may be happy, or unhappy with the project and do not trust the HIA team. Therefore, it needs skilled person and good preparedness so that the audience can trust and understand the information.

In general the purposes of risk communication are:

1) Promote the understanding among all stakeholders concerning issues in consideration throughout the operation.

- 2) Educate to raise the recognition about the potential hazards.
- 3) Achieve the ultimate gold transparently and harmoniously.
- 4) Create good understanding on the decision.
- 5) Promote the trustworthiness and confidence among the stakeholders.
- 6) The relationship among the stakeholders is better.
- 7) Promote appropriate participation pattern among stakeholders.

A risk communication team should be set up and comprised of high level of management who can make decision on communicating issue; experienced public relation personnel, and technician whose experience on the issue and risk evaluation. They should set up plan which is approved by the top management of the unit and specified target stakeholders. In this case, there are 2 groups, i.e. workers and community nearby the project.

Steps of communication process are:

1) Determine hazards from the description of the communicated project/plan/policy, and prepare initial information and data of the related risk including the knowledge and perception of the target audience.

2) Clearly define the objective of the communication, in general are:

- Create understanding and trustworthiness to the organization.
- Create awareness.
- Create understanding in method of problem solving.

- Develop communication skill.
- Convince the target to agree and do so.

3) Define the scope of communication according to the content and audience. The team has to evaluate the audiences' worried issues e.g. life style and health; reliability of the known information; risk management process; including the characteristic of the audiences concerning the reading ability, understanding of the issue and feeling to the communicating organization.

4) Design the content to communicate. Make it easy to understand considering read ability, feeling/anxiety about the risk, and experience on the hazards. Do not use the technical terms, convey the big picture and point out the important issues. The following questions should be considered.

- What are the issues that the audience already realizes?
- What are the issues that the audience wants to know?
- What are the issues that the audience need to know?
- Is the conveying information true?
- Is the conveying information can be interpreted in the other ways?
- 5) Set up flexible communication table so that every concerned person or team can be prepared.
- 6) Step of communication.

- Introduction to build trust and confidence by starting with the concern and the identified risk, and then mention the important issue, the organization's commitment, objectives, and action plan.

- The main information or issues needed to communicate should not exceed 3 issues and do not forget to give the information supporting the main issues.

- Conclusion. Before end the communication the important issue must be concluded.

7) Evaluation the communication. After finish the risk communication, the evaluation should be conducted by asking the following questions.

- Do the results come out as the purpose?
- Any action is needed to be done to meet the purpose?
- What could be done good and why?
- What does need to be improved and why?
- What is learned from this communication?

The feedback from the audiences should be collected for future improvement as well.

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APPENDICES

Appendix A Enamel Industry

The Enamel factory studied in this manual has been established at Bangna-Trad road, Tumbon Bang-Soa-Tong, Aumpor Bang-Soa-Tong, Samut Prakarn province; on 200 rai land. There are 5 buildings: 4 production buildings and one office.

The products in the market are emulsion paint, metallic paint, vanish, thinner and clear lacquer. The quantity produced a year is approximately 32 million gallons. The total employees are about 2000, but only 420 workers at the enamel plant. The products of this plant are wood stain, enamel, primer, vanish, thinner and urethane; approximate produced quantity is 9 million gallons/yr.

According to the study, survey and review literature the following are the knowledge on the enamel factory.

1. Chemicals and raw materials. Usually the enamel compost of 4 major components. These are:

1.1 Pigments. There are 2 kinds of pigment, i.e. powder and granule. Each color comes from each pigment. The pigments normally used in the enamel factory are:

1) White: Titanium Dioxide, Zinc Oxide and Zinc Sulfide.

2) Black: Carbon Black, Graphite and Iron Black.

3) Dark blue: Copper phthalocyanine and Iron Black.

4) Red: Red Lead, Iron Oxide and Cadmium Reds.

5) Yellow: Lead Chromate and Chromate une Zinc Chromate.

6) Orange: Cadmium Orange and Basic Lead Chromate.

7) Green: Chromium Oxide and Hydrated Chromium Oxide.

1.2 Solvent. There are several solvents used in the enamel factory. Each formula may use different solvent. Normally the solvents are:

1) Hydrocarbon: Xylene, Toluene, Hexane, Heptane and White Spirit

2) Ketone: Acetone, Methyl Isobutyl Ketone (MIBK) and Methyl Ethyl Ketone (MEK)

3) Ester: Cyclohexanon, Ethyl Acetate and Buthyl acetate.

4) Alcohol: Methyl alcohol, Ethyl alcohol and Isobuthyl alcohol.

5) Glycol. Cellolose and Ethyl Ethyl Ethylene.

1.3 Resin. It is polymer, one of the products of downstream petrochemicals. It could be in solid or liquid form. Those used in the enamel factory are: Vinyl, Epoxy, Acrylic, Limeseed oil, tunk oil, Soybean.

1.4 Additive. It is the chemical used for enhance or improve quality of the product for example, binder – increase binding ability of the paint; drier – shorter drying period, anti-setting agent, Wax, Anti foam, fungicide. Thus they are different kinds of chemicals with the required property conform with the prominent point of the product

Besides the major four chemicals mentioned above, acid is another chemical used to accelerate the dissolution of the pigment and resin in water. The widely used is formic acid, hydrochloric acid and acetic acid.

2. Production process. There are 3 important parts:

2.1 Receive and store chemicals and raw materials. Usually there are 2 methods depending on forms and quantity of the chemicals.

1) Solvent/liquid stage. The solvent or liquid chemicals used in large quantity, e.g. Xylene, Toluene, LPG and Soybean, normally are delivery by tank car and stored in large tank. They are conveyed to the process by piping system or transferred in to 200 litter containers and bring to the production process area by forklift.

2) Liquid or solid chemicals contained in small container e.g. 200 litter tank or paper or plastic bag. They are transport to the factory by truck and stored in the raw material storage building, e.g. Nitrocellulose (NC) pigment, resin, and additives.

2.2 Enamel production. There are 7 steps as showed in Figure 3.

1) **Preparation.** Bring all raw materials from the storage building and set aside the mixer tank.

2) Initial mixing. Put all raw materials, e.g. pigment, resin, solvent and additive in to the mixer tank. The mixer tank has a stirrer in the middle and a lid to close the tank. It is a high speed mixer. There are 2 sizes of the mixing tank; large tank has capacity of 400 gallons and the small has the capacity of 30 - 40 gallons. The large tank must be fixed at one location while the small one can be mobiled.

3) Grinding. Transfer the ingredients from the first tank to the metal ball mill to agitate and grind the pigment particles to disperse them throughout the paint.

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4) Mixing. After grinding the color of the paint turn to be darker, then add the rest of solvent and additive in to the mixer.

5) Adjust the color. This step is to adjust the color and quality (viscosity, density, color shade, fineness) of the paint to conform with the standard or its specification.

6) Filtration and filling. Filter the paint to separate the coarse particles, and then fill it in the 5, 1, and ½ gallon cans. The filling could be automatic or manual. The large factory may has both kinds but for the small one usually has only manual. For spray painting, in this step the glass bead will be put into the can first, and then fill in the paint and LPG in last step before close the can and put on the label identifying color.

7) Store in products storage building. The products are kept here waiting for distribution to selling center or customers throughout the country.



Figure 3 Paint production process

2.3 Products distribution to the market. The products may be transferred to the customers by 1) the factory ship the products to the distributors in the provinces by trucks, or 2) the customers come to pick up products at the factory. The products are unloaded from the shelf using forklift and bring to the loading point where the trucker can load them on the truck.

3. Workplace hazards.

As the result of the walkthrough survey in the production line, workplace and surrounding area, the potential health and safety hazards to workers and community are:

3.1 Chemical hazards. Chemicals and raw materials used in the production process may disperse or evaporate into the air at any period of the process because the mixer and vessel are not completely closed. Health effects of these chemicals are presented in Table 19. The results of the air sampling and analysis of the airborne chemicals are in Table 17.The concentrations of some chemicals exceeded the TLV suggested by ACGIH, i.e. benzene, trichloroethylene and chloroform.

Besides can cause health effects, some chemicals have strong odor which may annoy or cause mental health problem of the workers and people who live nearby the factory. However, currently we do not have standard threshold limit for odor yet. The ministerial regulations of the Ministry of Industry defined standard and test method for odor from the factory B.E. 2548. By this regulation the standard are divided into 2 sets, one for industrial area and the other for outside industrial area. The example of the factory under this regulation are the distillery, animal food manufacturing industry, sugarhouse, etc. while the chemicals and paint or enamel factory are not included. The reason is that the chemicals could harm the testers' health.

No	Chemicals	Area Sampling (ppm.)			Personal sampling (ppm.)			TI V
110.	Chemicals	Low	Avg.	Max.	Low	Avg.	Max.	IL,
1	Hexane	0.005	0.015	0.027	0.045	0.030	0.019	50
2	Acetone	0.026	0.087	0.170	0.152	0.316	0.523	500
3	Ethyl Acetate	0.478	1.041	1.750	1.450	2.055	2.766	400
4	MEK	0.064	0.277	0.479	0.157	0.794	1.599	200
5	IPA	0.522	0.802	1.058	0.923	1.712	2.726	200
6	Dichloromethane	1.443	1.860	2.180	1.735	3.617	6.547	50
7	Ethanol	0.000	0.035	0.068	0.025	0.185	0.396	1,000
8	Benzene	0.711	1.064	1.574	0.579	2.341	5.488	0.5
9	Trichloroethylene	0.094	2.488	9.006	0.117	7.887	30.442	10
10	MIBK	0.165	0.620	0.916	0.632	1.606	3.415	200
11	Chloroform	0.878	1.986	3.000	1.984	5.103	10.634	10
12	Toluene	0.145	0.730	1.756	0.663	2.522	5.406	20
13	Butyl Acetate	0.044	0.122	0.319	0.045	0.109	0.225	150
14	Ethyl benzene	0.029	0.177	0.605	0.027	0.062	0.132	100
15	p-Xylene	0.031	0.061	0.085	0.046	0.161	0.247	100

 Table 17 Airborne concentration of chemicals in the Enamel factory.

No.	Chemicals	Area Sampling (ppm.)		Personal sampling (ppm.)			TLV	
	Chemicals	Low	Avg.	Max.	Low	Avg.	Max.	11,
16	m-xylene	0.021	0.069	0.188	0.034	0.249	0.497	
17	Butanol	0.233	0.353	0.437	0.286	0.659	1.364	50
18	0-xylene	0.036	0.054	0.066	0.044	0.092	0.193	100
19	Cyclohexanone	0.030	0.058	0.105	0.070	0.093	0.118	25
20	Styrene	0.035	0.075	0.152	0.063	0.083	0.101	20
21	Cyclohexane	0.062	0.532	0.883	0.314	0.477	0.581	300
22	Total Dust (mg/m ³)	0.150	0.160	0.170	-	-	-	10

 Table 17 Airborne concentration of chemicals in the Enamel factory.

3.2 Physical hazards. Heat, vibration, light, noise etc. are in this category. They may arise from the production process in the level that harm to workers' health. Noise and vibration could occur during the mixing and grinding while heat and light are unlikely to occur from the process. Nevertheless the insufficient light may exist in some area where the light in working station is poor. These did not exist in the factory which was studied.

Noise level measured in the area where the workers work such as at the mixer, the grinding tank are presented in Table 18. The noise levels in all areas were lower than 90 dBA, and there were 2 areas exceed 85 dBA. (See layout, Figure 4). However, the worker did not stay in the production line at all time of working hours; they mobile to other area including the rest room. Therefore, their exposure to noise for 8 hours should below 85 dBA. The factories do not need to set up hearing conservation program as in the ministerial regulation of the Ministry of Labour.

No.	Area	TWA (dBA)	OEL (dBA)
1	Mixer	88.3	90
2	Enamel 2 nd floor at area 1	78.0	90
3	Enamel 2 nd floor at area 2	77.0	90
4	Enamel 1 st floor at area 1	86.6	90
5	Enamel 1 st floor at area 2	84.2	90
6	Enamel 1 st floor at area 2 (while filtration)	82.0	90

Table 18 Noise level in workplace. (Also see layout)





3.3 Ergonomics. Low back pain due to improper materials transfer e.g. manual lifting in filling process, load products on to the pallet etc.

3.4 Safety. Pallet, product, container falls over part of body, tumble down, hand-lift or forklift run over feet, and fire or explosion due to flammable chemicals.

3.5 Bio hazards. Fungi, mold, bacteria etc., are not normally hazards in the enamel factory and do not found in the study factory.

4. Air, water, pollution and waste.

As the literature review, waste and pollutants from the enamel factory are solvent used to clean equipment, container, mixer, etc. and expired paint, empty chemical containers, etc. Table 20 present type of pollutants and waste including estimated quantity of them and control measures.

Chemicals	Property	Health effect	Health surveillance
Benzene	Colorless to light-yellow	Acute effects	- Occupation and exposure history
C_6H_6	liquid with an aromatic	- Inhalation: irritation eyes, nose, respiratory system; CNS depression: dizziness;	-Physical examination looking for
	odor.	headache, nausea, staggered gait; anorexia, lassitude (weakness, exhaustion).	anemia, Arrhythmia, rash in
3		- Skin: dry, irritation.	exposed area.
		Chronic effects	- Medical examination
		- Bone marrow depression, potential occupational carcinogen – leukemia; ,	1) Complete Blood Count and
\sim		dermatitis, psychotropic symptom.	analysis
		Some studies suggest that repeated, frequent overexposure to organic solvents over	2) Leukemia.
		months or years can have long-lasting and possibly permanent effects on the nervous	
		system. The symptoms of these long-term effects include fatigue, poor coordination,	
		difficulty in concentrating, loss of short-term memory, and personality changes such	
		as increased anxiety, nervousness, and irritability.	
Toluene	Colorless liquid with a	Acute effects	Medical exam for treatment of
C_7H_8	sweet, pungent, benzene-	- Inhalation: irritation eyes, nose; lassitude (weakness, exhaustion), confusion,	toluene poisoning: EKG test,
$(C_6H_5CH_3)$	like odor.	euphoria, dizziness, headache; dilated pupils, lacrimation (discharge of tears);	Creatinine Phosphokinase (CPK),
3		anxiety, muscle fatigue, insomnia; paresthesia; expose at high concentration can	chest x-ray, minerals in blood,
		cause unconsciousness, and even death.	gases in blood, function of liver
		- Skin and eyes: red, rash, swell, dry, inflammation, eye irritation and inflammation.	and kidney.
\sim		Chronic effects	
		- dermatitis; liver and kidney damage, tiredness, confusion, weakness, drunken-type	
		actions, memory loss, nausea, loss of appetite, and hearing and color vision loss.	
		- Breathing very high levels of toluene during pregnancy can result in children with	

Chemicals	Property	Health effect	Health surveillance
		birth defects and retard mental abilities, and growth. We do not know if toluene	
		harms the unborn child whose the mother is exposed to low levels of toluene during	
		pregnancy.	
Mixed xylene	Colorless liquid with an	Acute effects	- Occupation and exposure
C_8H_{10}	aromatic odor, insoluble.	- Inhalation: at 100 ppm may cause CNS depression: dizziness, headache, vomit; at	history: ask for irritation of
		200 ppm irritation of respiratory tract, eye, lung, chest pain, at very high	respiratory tract and skin.
3		concentration e.g. in confine space may cause pulmonary edema, and death.	- Physical exam: listen to lung,
2 0		- Skin: irritation- redness, and swelling and dermatitis.	skin
		Chronic effects	- When the symptom appear should
· ·		- Can cause dry, red, cracked skin (dermatitis) following skin contact. May harm the	have EKG test, Creatinine
		nervous system.	Phosphokinase (CPK), chest x-ray,
			minerals in blood, gases in blood,
			function of liver and kidney
Styrene	Colorless to yellow, oily	Acute effects	- Occupation and medical history;
C_8H_8	liquid with a sweet, floral	- Inhalation: can irritate eyes, nose, throat, and lungs. Extreme overexposure (for	exposure history.
	odor.	example, in an enclosed space) could result in pulmonary edema, a potentially life-	In case of emergency, should
3		threatening condition in which the lungs fill with fluid. Styrene normally does not	have chest x-ray, mineral level in
2 2		have substantial effects on the eyes, nose, throat, or lungs. Also can harm central	blood, and EKG.
\sim		nervous system - headache, fatigue, dizziness, confusion, drowsiness, malaise,	- Medical check-up for worker
		difficulty in concentrating, and a feeling of intoxication.	who needs to wear respiratory
		- Skin & eye: Liquid styrene splashed in the eye stings and may damage the surface	protection.
		of the eye, but the eye usually heals within a few days	

Chemicals	Property	Health effect	Health surveillance
		Chronic effects	
		- Dermatitis and effect on CNS as other organic solvent, and may cause asthma.	
Cyclohexane	Colorless liquid with a	Acute effects	
$C_{6}H_{12}$	sweet, chloroform-like	- Inhalation: irritate eyes, nose, throat, and lung; dizziness, vomit, unconscious.	
	odor.	Chronic effects	
		Prolonged or repeated contact can cause a skin rash, dryness, itching and redness; can	-
		cause headache, dizziness, nausea and vomiting, light-headedness, drowsiness, and	
\sim		passing; may damage the liver and kidney.	
Acetone	Colorless liquid with a	Acute effects	
C ₃ H ₆ O	fragrant, mint-like odor.	- Inhalation: Can irritate the nose and throat. At high concentrations: can harm the	
3		nervous system. Symptoms may include headache, nausea, dizziness, drowsiness and	
		confusion. A severe exposure can cause unconsciousness.	
		- Skin contact: May cause mild irritation. Can be absorbed through the skin, but	
\sim		harmful effects are not expected.	-
		- Eye contact: Causes moderate to severe irritation. Symptoms include sore, red eyes,	
		and tearing. The vapor also irritates the eyes.	
		Chronic effects	
		- Can cause dry, red, cracked skin (dermatitis) following skin contact. May harm the	
		nervous system.	
Methanol	Colorless liquid with a	Acute effect	- Occupation and medical history
CH ₄ O	characteristic pungent	- Inhalation: drowsiness, a reduced level of consciousness (CNS depression),	- Laboratory test: mineral level in
CHCl ₃	odor.	confusion, headache, dizziness, and the inability to coordinate muscle movement	blood to calculate anion gap, liver

Chemicals	Property	Health effect	Health surveillance
		(ataxia). Concentration 6000 ppm may cause nausea, vomiting (emesis), and heart	and kidney function; lactic acid
		and respiratory (cardiopulmonary) failure.	level; serum osmolality; and
		- Skin contact: Irritation, redness, and pain.	osmolar gap, arterial blood gas
		Chronic effects	
		- The most common permanent adverse health effects following severe methanol	
		poisoning are damage to or death of the nerve leading from the eye to the brain (optic	
		neuropathy or atrophy), resulting in blindness.	
		- Chronic exposure may cause headache, dizziness, lack of an appetite (anorexia);	
		severe abdominal pain, gastrointestinal bleeding (hemorrhage), diarrhea, liver	
		function abnormalities, and inflammation of the pancreas (pancreatitis); visual	
		disturbances, blurred vision, sensitivity to light (photophobia), visual hallucinations	
		(misty vision, skin over the eyes, snowstorm, dancing spots, flashes), partial to total	
		loss of vision, and rarely eye pain.	
Isopropyl alcohol	Colorless liquid with the	Acute effects	- Occupation and medical history;
(IPA)	odor of rubbing alcohol.	- Inhalation: can irritate the nose and throat causing coughing and wheezing.	examination of skin, liver, kidney
C_3H_8		Overexposure can cause headache, dizziness, confusion, loss of coordination,	and respiratory system should be
130		unconsciousness and even death	stressed.
		- Skin & eye: can irritate and burn the skin and e	
		Chronic effects	
		- Prolonged or repeated contact can cause a skin rash, itching, dryness and redness.	
Ethyl alcohol	Clear, colorless liquid	Acute effects	- Occupation and medical history
C_2H_6	with a weak, ethereal,	- Inhalation: can irritate the nose, throat and lungs causing coughing and/or shortness	- Physical check-up for
Chemicals	Property	Health effect	Health surveillance
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3	vinous odor.	of breath; can cause headache, drowsiness, nausea and vomiting, and	myokymia eyelid, confusion,
		unconsciousness. It can also affect concentration and vision. Ethyl alcohol 100	ataxia, other ethanol complication
		mg/100 ml blood, may cause slow response; may inhibit glucose generation in child	e.g. low blood sugar, headache,
\sim		and patient with chronic liver disease, but not enough to cause coma, deep sleep or	accident, meningitis.
		depress respiratory function.	
		- Skin & eye contact: irritate the skin and eye.	
		Chronic effects	
		- May increase the risk of certain types of cancers (liver, esophagus, breast, prostate,	
		and colorectal) in humans	
		- May cause spontaneous abortions, as well as birth defects and other developmental	
		problems.	
		- Can cause drying and cracking of the skin with peeling, redness and itching.	
		- Repeated high exposure may affect the liver and the nervous system.	
Chloroform	Colorless liquid with a	Acute effects	- Occupation and exposure history
CHCl ₃	pleasant odor.	- Inhalation: n irritate the nose and throat; depress CNS - cause headache, nausea,	- Laboratory test: EKG, mineral
		dizziness, loss of coordination, lightheadedness, and passing out. High exposure can	level in blood, liver and kidney
		cause the heart to beat irregularly or to stop. This may cause death	function, blood clot.
		- Skin & eye: can irritate and burn the skin and eyes, and cause eye tearing and	
\sim		reddening.	
		Chronic effects	
		- IARC classify as 2A group (suspect human carcinogen). There is some evidence	
		that it causes liver, kidney and thyroid cancer in animals.	

Chemicals	Property	Health effect	Health surveillance
		- may damage the liver, kidneys and nervous system.	
Trichloroethylene	Colorless liquid (unless	Acute effects	- Occupation and exposure history
C_2HCl_3	dyed blue) with a	- Inhalation: Irritate respiratory tract, headaches, dizziness, large amounts of	- Laboratory test: EKG, mineral
	chloroform-like odor.	trichloroethylene may cause coma and even death. Some people who breathe high	level in blood, liver and kidney
		levels of trichloroethylene may develop damage to some of the nerves in the face.	function.
		Other effects seen in people exposed to high levels of trichloroethylene include	Special attention in examination
1		evidence of nervous system effects related to hearing, seeing, and balance, changes in	to:
2		the rhythm of the heartbeat, liver damage, and evidence of kidney damage.	Central nervous system,
		- Skin: rashes, irritation skin and eye.	Peripheral nervous system
\sim		- Can be transferred from mother to fetus via placenta and milk.	(strength, sensation, DTR),
		Chronic effects	Cardiovascular system,
		Potential occupational carcinogen.	Liver, Skin (rash, erosion, ulcer,
		Cancer in animals: liver & kidney cancer	pigment, eczema, etc.)
Methyl Ethyl	Colorless liquid with a	Acute effects	- Occupation and medical history.
Ketone	moderately sharp,	- Inhalation: Irritation of respiratory tract, headache, vomit, confuse, numb of hand	- Examination: chest x-ray, and
(MEK)	fragrant, mint- or	and leg, CNS depress.	other as present sign and
CH ₃ COCH ₂ CH ₃	acetone-like odor.	- Skin & eye: Sing irritation and dry; severe irritation of eye, burn, and temporary	symptom.
3		blur vision.	
		Chronic effects	
		- CNS depression, effect peripheral nervous system, inflammation of skin, skin rash,	
\sim		itching, and thinner skin.	

Chemicals	Property	Health effect	Health surveillance
Methyl Isobutyl	Colorless liquid with a	Acute effects	- A pre-employment medical
ketone	pleasant odor.	- Inhalation: irritation eyes, skin, mucous membrane; headache, narcosis, coma	examination is advised for
(MIBK)		- Skin & eye: Irritation	workers who will be regularly
$C_6H_{12}O$		Chronic effects	exposed to MIBK. should
3		- Dry skin, dermatitis.	emphasize on examination of the
		- Effect on CNS.	central
			nervous system, respiratory tract,
			gastrointestinal tract, and skin.
Hexane	Colorless liquid with a	Acute effects	- Electromyography (EMG)
$CH_3[CH_2]_4CH_3$	gasoline-like odor	- Inhalation: irritation eyes, nose; nausea, headache; peripheral neuropathy: dizziness;	- Vision test.
•		chemical pneumonitis (aspiration liquid)	
3		-Skin & eye: Irritation, rash.	
		<u>Chronic effects</u>	
		- Effect on nervous system, dermatitis; muscle weak; numb extremities, Narrow field	
		of vision, vision nerve damage.	
Ethyl acetate	Colorless liquid with an	Acute effects	- Preplacement exam: Occupation
CH ₃ COOC ₂ H ₅	ether-like, fruity odor.	- Inhalation: Irritation, headache, confusion, lose consciousness	and exposure history
2		- Skin & eye: Irritation, severe dry.	
		Chronic effects	
		- Damage eye, effect on liver, kidney and respiratory system.	
\sim			

Property	Health effect	Health surveillance
Colorless liquid with a	Acute effects	- Occupation and exposure history
chloroform-like odor	- Inhalation: Effect on nerve system: lassitude (weakness, exhaustion), drowsiness,	- Med exam for respiratory
	dizziness; numb, tingle limbs; nausea;	protection use.
	- Skin & eye: irritation eyes, skin.	- Med check-up for numbness,
	<u>Chronic effects</u> - potential occupational carcinogen.	liver function, CBC.
Colorless liquid with a	Acute effects	Preplacement exam:
fruity odor.	- Inhalation: headache; drowsiness; dryness upper respiratory system, skin; narcosis.	Occupation and exposure history.
	- Skin & eye: Irritation, dry, rash.	
	<u>Chronic effects</u> - Severe irritation and inflammation of skin. May damage lung, and kidney.	
Colorless liquid with an	Acute effects	- Preplacement exam: Occupation
aromatic odor.	- Inhalation: Irritation to mucous and upper respiratory tract; CNS depression;	and exposure history.
	 Skin & eye: Irritation <u>Chronic effects</u> Effect of blood system, and liver. 	
	Property Colorless liquid with a chloroform-like odor Colorless liquid with a fruity odor. Colorless liquid with an aromatic odor.	PropertyHealth effectColorless liquid with a chloroform-like odorAcute effects - Inhalation: Effect on nerve system: lassitude (weakness, exhaustion), drowsiness, dizziness; numb, tingle limbs; nausea; - Skin & eye: irritation eyes, skin.Colorless liquid with a fruity odor.Acute effects - potential occupational carcinogen.Colorless liquid with a

Chemicals	Property	Health effect	Health surveillance
Aluminum	Silvery-white, malleable,	Acute effects	- Chest x-ray
Al	ductile, odorless metal.	- Inhalation: respiratory system: cough, irritation, pulmonary edema.	- Lung function test.
		- Skin & eye: irritation eyes, skin. Usually aluminum itself does not cause irritation	
		but its compound e.g. lithium aluminium hydride.	
		<u>Chronic effects</u>	
\sim		- Emphysema, COPD (chronic obstructive pulmonary disease), pneumoconiosis.	
Lead	A heavy, ductile, soft,	Acute effect	- Laboratory test:
Pb	gray solid.	- Dizziness, vomit, colic, confusion, sleepless, restless. These are usually seen in	Hematology – CBC (HGB, HCT,
NFPA 704:		child.	WBC, MCV,
data unavailable		<u>Chronic effects</u>	MCH, MCHC),
		- lassitude (weakness, exhaustion), insomnia; facial pallor; anorexia, weight loss,	RBC morphology, Serum
		malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor;	chemistry: BUN and creatinine,
		paralysis wrist, ankles; encephalopathy; kidney disease; irritation eyes; hypertension1	Blood lead and zinc
			protoporphyrin (ZPP)
			Physical examination:
			Special attention in examination
			to:
			Head, eyes, ears, nose and throat,
			Visual disturbances, CNS, PNS
			(strength, sensation, DTR),
			Cardiovascular system, Gums
			(e.g. lead lines?), Abdomen.

Chemicals	Property	Health effect	Health surveillance
Cadmium	Silver-white metal, blue-	Acute effects	- Occupation and exposure
Cd	tinged lustrous, odorless	- Inhalation: At concentration of 1 mg/m ³ for 8 hours may cause pneumoconiosis, in	history.
	solid	severe case may have pulmonary edema within 18 hours after exposure; dyspnea	- Med exam for respiratory
NFPA 704:		(breathing difficulty), cough, chest tightness, substernal (occurring beneath the	protection use.
data unavailable		sternum) pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia	- Lung function test.
		(loss of the sense of smell). Expose at concentration exceed 51 mg/m ^{3} could be death	- Chest x-ray.
		within 4-7 days.	
		- Swallow more than 12 mg/L may have food poisoning symptom: vomit, dizzy,	
		stomachache, diarrhea, shock and may be death.	
		Chronic effects	
		- Emphysema, proteinuria, mild anemia; cadmium poisoning – Itai- itai; potential	
		occupational carcinogen.	
Respirable dust	< 10 micron, can reach to	Acute effects	- Occupation and exposure
	the lung.	- Inhalation: Cough, running nose, sneeze, sinusitis, phlegm, difficult breathing, chest	history.
		pain, and wheeze.	
		- bronchitis, pneumonia	
		Chronic effects	
		- Irritation and damage the lung tissue; increase chance of lung infections;	
		emphysema;	
		- Dust contain other chemical such as Arsenic, Chromate ,Polyaromatic hydrocarbon	
		(PAH), Nickel, radioactive particle, may cause lung cancer.	

Pollutant	G	Characteristic	Quantity	Generation		
& Waste	Sources	of Pollutant	(ton/yr.) ⁽¹⁾	rate/factory	i reatment/Disposai	Control at source
1 .Air	Transfer and put	- VOCs	- VOCs 35	- VOCs 10 kg./ ton	Dust:	- Transfer raw material using
Pollution	the chemical in	- Pigment dust	kg./ton of	of paint	Install dust control unit, in case	closed system.
	mixer.		paint	- Dust 1.5-3 kg./ ton	that the dust concentration	
	Mixing	- VOCs	- dust 5.2-	of paint	exceed the standard.	- Install local exhaust system
		-Pigment dust	10.4 kg./			which can be turned on/off when
			ton of paint			needs such as when poring the
						material and chemical in the
						mixer.
						- Close the mixer lid while mixer
						is in operation.
						- Select lower toxic chemicals.
	Grinding	VOCs			VOCs	- Close the mixer lid
					1.Adsorption with activated	- Enclose the grinder.
	Adjust the color	VOCs			carbon.	- Close the mixer lid while mixer
	(Mixing)				2. Absorption with appropriate	is in operation.
	Cleaning and	VOCs			absorber. (Wet Scrubber)	- Enclose the washer and install
	washing the					local exhaust system.
	equipment and					- Have washing tub equip with
	machine.					cleaning equipment e.g. brush,

 Table 20 Waste and Pollutants from the enamel factory.

 Table 20 Waste and Pollutants from the enamel factory.

Pollutant & Waste	Sources	Characteristic of Pollutant	Quantity (ton/yr.) ⁽¹⁾	Generation rate/factory	Treatment/Disposal	Control at source
2.Waste water	Wet Scrubber	- COD			- Collect and bring to waste	chemical and condenser to condense the chemical vapor. (For large factory)
3. Garbage and waste	Transfer and put the chemical in mixer.	Paper boxes, paper bags, plastic bags Chemical containers; cloth used for cleaning equipment and machine; contaminated gloves; paint waste.	344 310	0.6 kg./ ton of paint 20 kg./ ton of paint	Take paint/chemical contaminated cloth, paper, and other waste out of general garbage and keep in the container with the lid, waiting for collection and disposal by certified company.	 Take reusable waste from contaminated garbage and reuse or sell them. Supervise the workers to well empty the container while pouring chemicals/material in the mixer. Some container should be cleaned and reused.
	Mixing Grinding (ball mill	Paint spilled	2.4	100 kg./ ton of paint	- Keep in tight closed container and ship to dispose by	- Reduce the spill by having closed system

 Table 20 Waste and Pollutants from the enamel factory.

Pollutant & Waste	Sources	Characteristic of Pollutant	Quantity (ton/yr.) ⁽¹⁾	Generation rate/factory	Treatment/Disposal	Control at source
Adjust					certified agency.	- Dry clean using sand or saw
color						dust, and then ship to dispose.
Filtration	Paint residual					
Filling	Paint residual and		12	800 kg./ ton of paint		
	substandard					
	quality paint					
	Washing	Contaminated	52	15 kg./ ton of paint	- Keep in tight closed container	- Use the cleaning solvent for
	equipment and	solvent and			and ship to dispose by	next batch.
	machine	paint residual.			certified agency.	- Use high pressure pump.
						- Clean the mixer immediately
						after finish; do not allow the
						paint dry in the mixer.

No.	Chemicals	TLV	IDHL	AEGL-1	AEGL-1	AEGL-2	AEGL-2	ERPG1*	ERPG2*	MRL*	REL*	IARC*	non	Cancer*
				(1-h)*	(8-h)*	(1-h)*	(8-h)*						cancer*	
1	Benzene	0.5	500	170 ⁱ	29 ⁱ	2600 ⁱ	640 ⁱ	160	480	0.029	1.3	1	0.03	7.8 x10 ⁻⁶
2	Toluene	20	500	750 ⁱ	750 ⁱ	4500 ⁱ	2400 ⁱ	190	1100	3.8	37	3	5	-
3	Mixed Xylene	100	900	560 ⁱ	560 ⁱ	4000 ⁱ	1700 ⁱ	-	-	8.7	22	3	0.1	-
4	Styrene	20	70	85 ⁱ	85 ⁱ	550 ⁱ	550 ⁱ	210	1100	21	21	2B	1	-
5	MTBE	50	-	180 ⁱ	180 ⁱ	2100 ⁱ	1400 ⁱ	-	-	7.2	-	3	3	$2.6 \text{ x} 10^{-7}$
6	Cyclo-hexane	10		-	-	-	-	-	-	-	-	-	-	-
7	Cyclohexanone	20		-	-	-	-	-	-	-	-	3	-	-
8	Acetone	500	100	-	-	-	-	-	-	-	-	-	-	-
9	Ethylenedichloride	10	50	-	-	-	-	200	810	-	-	2B	2.4	2.6 x10 ⁻⁵
10	Methanol	200	6000	690 ⁱ	350 ⁱ	2700 ⁱ	680 ⁱ	260	1300	-	28	-	20	-
11	Isopropyl alcohol	200	2000	-	-	-	-	-	-	-	-	3	-	-
12	Ethyl alcohol	1000	3300	-	-	-	-	-	-	-	-	-	-	-
13	Chloroform	10	500	-	-	310 ⁱ	140 ⁱ	-	240	0.49	0.15	2B	0.098	-
14	Trichloroethylene	1	1000	700 ⁱ	410 ⁱ	2400 ⁱ	1300 ⁱ	540	2700	11	-	2A	0.002	4.1 x10 ⁻⁶
15	Methy Ethyl Ketone	200	-	-	-	-	-	-	-	-	-	-	-	-
16	Methy Isobutyl ketone	200	-	-	-	-	-	-	-	-	-	-	-	-
17	Hexane	50	1100	-	-	12000 ⁱ	12000 ⁱ	-	-	-	-	-	0.7	-
18	Ethyl acetate	400	2000	-	-	-	-	-	-	-	-	-	-	-
19	Methylene chloride	50	2300	600 ⁱ	-	1900 ⁱ	210 ⁱ	1000	2600	2.1	14	2B	0.6	1 x10 ⁻⁸
20	Butyl acetate	150	1400	-	-	-	-	-	-	-	-	-	-	-
21	Ethyl benzene	100	800	140 ⁱ	140 ⁱ	4800^{i}	2500 ⁱ	-	-	22	-	2B	1	2.5 x10 ⁻⁶

 Table 21 Threshold limits for chemicals in enamel factory.

No.	Chemicals	TLV	IDHL	AEGL-1	AEGL-1	AEGL-2	AEGL-2	ERPG1*	ERPG2*	MRL*	REL*	IARC*	non	Cancer*
				(1-h)*	(8-h)*	(1-h)*	(8-h)*						cancer*	
22	Butanol	50	-	-	-	-	-	-	-	-	-	-	-	-
23	Aluminum	1*	-									1	-	-
24	Lead	0.05*	100*	-	-	-	-	-	-	-	-	2B	1.5 x10 ⁻⁴	-
25	Cadmium	0.01*	9*	-	-	-	-	-	-	3x10 ⁻⁵	-	1	1x10 ⁻⁵	1.8 x10 ⁻³
26	Respirable dust	10	-	-	-	-	-	-	-	-	-	-	-	-

 Table 21 Threshold limits for chemicals in enamel factory.

Note: f = final, i=interim, and p=proposed

* unit of mg/m³

Appendix B

HIA Tools

Project screening for HIA Example: Screening Questions Yes 1. Has a project, plan or policy been proposed? []] 2. Is there sufficient time to conduct an analysis before the final decision is made? []] 3. Does the decision have the potential to affect environmental or social []]	
Example: Screening Questions Yes 1. Has a project, plan or policy been proposed? 1. 2. Is there sufficient time to conduct an analysis before the final decision is made? 1. 3. Does the decision have the potential to affect environmental or social Image: Content of the potential of the poten	
Screening QuestionsYes1. Has a project, plan or policy been proposed?2. Is there sufficient time to conduct an analysis before the final decision is made?3. Does the decision have the potential to affect environmental or social	
1. Has a project, plan or policy been proposed?12. Is there sufficient time to conduct an analysis before the final decision is made?13. Does the decision have the potential to affect environmental or social1	No
2. Is there sufficient time to conduct an analysis before the final decision is made?3. Does the decision have the potential to affect environmental or social	
3. Does the decision have the potential to affect environmental or social	
determinants that impact health outcomes?	
4. Would health inequities be impacted? In what ways?	
5. Are the proposal's impacts to health likely to be significant in terms of the number of	
people impacted, the magnitude, breadth and/or immediacy of impacts?	
6. Do evidence, expertise, and/or research methods exist to analyze health impacts of the decision?	
7. Is health already being considered in the proposal or as part of the decision-	
making process?	
8. Are the links between the proposal and health or health determinants clear?	
9. Is the decision-making process open to the HIA and/or recommendations for	
changes to design, mitigations and/or alternatives?	
10. Would HIA findings and recommendations potentially improve the impact that the proposal has on health?	
11. Have public concerns about the health impacts of the decision been voiced or	
documented?	
12. Are the stakeholders and interest groups involved in the decision-making process?	
13. Do stakeholders have the capacity (resources, skills, etc.) to participate in the HIA?	
14. Would stakeholders use the HIA to inform or influence the decision-making process?	

- = uncertain or no not applicable

<u>Tool #2</u>						
Health issue/	risk f	facto	or sci	reen	ing f	for HIA
For each of the following categories.	For each of the following categories			Comments		
does the project have a potential	/e	е	al	10W		Specify which aspect of the
immest or	sitiv	ativ	utr:	, kn	V/A	project was the source of the
impact on	\mathbf{P}_{0}	Neg	Ne	Don	~	impact
	1. (Qual	lity (of life	e	
1.1 Traffic attributable						
1.2 Drug use?						
1.3 Compulsive gambling?						
1.4 Crime problem						
1.5 Community violence						
1.6 Prostitution problem						
1.7 Cultural and arts						
1.8 Community attractions						
1.9 Teenage pregnancy						
1.10 Accident						
1.11 Economic and income of profit in						
community						
1.12 Access to health care service						
1.13 Utilities						
1.14 Resource efficiency						
1.15 Land development						
1.16 Community clean and tidy						
1.17 Education						
1.18 Waste management						
2. P	hysi	cal e	nvir	onm	ent	
2.1 Pollution (dust smoke, fume)	-					
2.2 Polluted water						
2.3 Soil quality						
2.4 Garbage						
2.5 Hazardous						
2.6 Stench						
2.7 Noise						
3	. н	lealt	h sta	tus		
3.1 Exercise						
3.2 Pestilence						
3.3 Adverse health effect						
3.4 Abortion						
3.5 Abnormal among newborn child						
3.6 Illness among children and elderly.						

<u>Tool #2</u>							
Health issue/	risk t	facto	or sc	reen	ing f	or HIA	
For each of the following categories.	Po	Potential Impact:				Comments	
does the project have a potential	ve	ve ve		wou		Specify which aspect of the	
impact on		Positi Negativ		Don' k	N/A	project was the source of the impact	
	4. Stress						
4.1 Satisfaction							
4.2 Feeling of safety							
4.3 Comfortable							
4.4 Supportive relationships with neighbors							
4.5 Access to community information							
5.	Nat	tural	cala	amit	y		
5.1 Flooding							
5.2 Storm							
5.3 Wildfire							
5.4 Landslide							
5.5 Barrenness							

Tool #3					
	Scoping				
Example 1 Health outcom	e /Determinant				
Research question	Impact Research	Methods	Responsible party		
	Questions				
What are the			•		
existing/baseline conditions					
related to the health					
determinants					
()?					
How will the project, plan,					
or policy impact baseline					
conditions					
()?					
What indicators can be used					
to measure baseline					
conditions (<i>road dust</i>) and					
impacts					
()					
Where will you find data					
for each indicator?					
()					
What methods will be used					
to assess baseline					
conditions and predicted					
impacts?					
How will you prioritize the					
research questions and/or					
indicators?					
How will you determine					
which ones will be included					
in the final scope of the					
study?					

<u>Summary</u> Team's opinion air pollution – (.....)....studynot study

Tool #4

Questionnaire Collecting Community Information/Data

Objectives of the questionnaire:

1) To collect the initial information/data of the community for consideration on the impact that may occur due to the project and what should be done to reduce or prevent the impact.

2) To have baseline data/information to compare with those in the construction and operation phases in order to monitoring and evaluation.

However, the HIA team should review this questionnaire before use and adjust or make the correction as need according to the context on the community and project/plan/policy.

The questionnaire is composed of 8 sections.

Section 1: General information Section 2: Socio-economics data. Section 3: Community health and environment Section 4: Structure and utilities Section 5: Public health Section 6: Financial Section 7: Emergency response Section 8: Local critical problems

Questionnaire Collecting Community Information/Data

Name of the community:.....

Section 1: General information

1. Location of the community:

.....

- 1) Sizekm²
- 2) Number of houses.....
- Boundary: north connected to:
 South connected to:
 East connected to:
 West connected to:
- 2. Population:
 - 4) Density of the populationperson/km²
 - 5) Number/sex/age group of population (Fill in the following table)

Age group (Yr)	Male	Female
<1		
1 - 6		
7 - 12		
13 -17		
18 - 60		
>60		

6) Birth rate.....% per yr. Death rate.....% per yr.

7) Number of disabled people.....

- 8) Number of chronic sick persons who need continuous care.....
- 9) Accident injury rate.....% Top three causes of accident.

1..... 2..... 3..... 4

5

- 3 Occupation of the population.
 - mployed and salf ampli-. 1 1 0 • 1

1) Estimated n	umber of empl	oyed and sel	f-employ per	sons in each	sectors.
Employed/Self-	Agricultural	Industry	General	Others	Not
employed			employed		employed
%					
Number					
 Average inc Employed a 	come			Baht/persor	n/yr.
3) Employed i	ate	and unen	iployed rate		
4) Local popul	lation	%; i	mmigrant fan	nily	%
5) Top three o	f the origins of	the immigra	nt families.		
1					
2		•••••			
3					
Social support netv	vork (Associati	on, foundatio	on, club, etc.)	:	
1)					
2)					
3)					
4)					
Health status of the	community.				
1) Incident or	prevalence rate	e of			
diseases			(Attach ta	able)	

- 2) Death rate due to communicable disease.....(Attach table) 3) Death rate due to non-communicable disease(Attach table)
- 4) Injury rate due to road accident.....(Attach table)

Section 2: Socio-economics data.

- 1 Number of liquor shop...... Number of pub and bar.....
- Drug addicted rate..... 2
- 3 Divorce rate:/month

- 4 Crime rate....../month
- 5 Number of nursery Number of kids in the nursery.....
- 7 Number of school.....

Level	Nı	ımber	Enough/Nat enough		
	Private Government				
G 1-6					
G 8-12					
College or University					

8 Number and purpose use of vehicles.

Number	Agricultural	Goods transportation	Fishery	Tourism
Car/truck/boat/ship				

9 Sport, Recreation, resting

- 1) Number of Park.....Enough □ Not enough
- 2) Public library.....Enough □ Not enough
- Number of sport field..... under whose responsible for taking care of.....
- Number of sport court..... under whose responsible for taking care of.....

Section 3: Community health and environment

1 Quality of place to live (good/bad - Explain) quantity (Enough and price)

.....

- 3 Quantity of garbage..... ton/day; the distance from house to landfill is enough or not; the system is good or not (Explain)

4 Waste disposal method.

√/×	Method	√/×	Method
	Put on the ground		Ferment
	Collect and burn		Burn in incinerator
	Landfill		Pay for taking out of the community
	Others		

Section 4: Structure and utilities

- 1 Communication and Traffic
- 2 Communication in and out bound is convenience, appropriate or not

	(explain)
	Number of red roads; the length
	Number of asphalt road; the lengthkm. \Box Enough \Box Not enough
	Number of concrete road; the lengthkm. \Box Enough \Box Not enough
	Number of other type; the lengthkm. \Box Enough \Box Not enough
5	Drinking water (Boiled tap water, Tap water, Bottled water, others)
6	Potable water (tap water, well, other sources)
7	Water supply system, clean and enough or not
8	Electricity is enough or not

Section 5: Public health

	1	Number of drug store					
	2	Number of clenique					
	3	Number of hospital (private	ea	nd government)			
	4	Number of health station					
	5	Number of health care perso	onnel in he	ealth station			
-	Physic	cian □ Enoug	h □ Not	enough			
-	Nurse	🗆 Enoug	h □ Not	enough			
-	Dentis	st□ Enoug	h □ Not	enough			
-	Pharm	acist 🗆 Enoug	h □ Not	enough			
-	Health	n promotion personnel	Enough	□ Not enough			
-	Health	officer	Enough	□ Not enough			

-	Sanitation officer Enou	ıgh	\Box Not enou	gh
-	Community health officer per	son	□ Enough	□ Not enough
-	Diseases normally found in the area 1	l)		
		2) .		
		3) .		
6. Einen				

Section 6: Financial

- 1 Budget (year...)...; income (not include subsidy money); expense (not include subsidy money).....
- 2 Taxation

Local taxleft (Accrual)
Land and Housing taxLeft
Trade mark tax left
Mine tax Left
Other (Specify) left

Section 7: Emergency response

1 Number of officer in fire brigade.

Gov. service officer	\square Enough	\Box Not enough
Staff	□ Enough	\Box Not enough
Employee	□ Enough	\Box Not enough
Volunteer	□ Enough	□ Not enough

2 Statistic of fire

Number of incident in last year
Number of death in last year
Number of injures in last year
Cost of property damageBaht. in last year
Assistant or support in the fire casesBaht. in last year

No.	o. Capacity (m ³)		Price	Source of budget

3. Fire engine \Box Enough \Box Not enough

3 Water truck \Box Enough \Box Not enough

No.	Capacity (m ³)	Year	Price	Source of budget

4 Cabin truck \Box Enough \Box Not enough

No.	Year	Pric	ce	Source of budget
5 I	addar truak	- Enough	- Not anou	ah

5 Ladder truck \Box Enough \Box Not enough

No.	Year bought	Price	Source of budget

6 Fireboat \Box Enough \Box Not enough

No.	Year bought	Price	Source of budget

No	Problem	Scale of problem			
110.	Trookin	0	1	2	3
1	Drug addicted				
2	Land for living.				
3	Unemployed				
4	Homeless people				
5	Illegal debt				
6	influential person				
7	Child and teenage				
8	Environment				
9	Life and property safety				
10	Illegal occupation				
11	Mountebankery				
12	Others				

Section 8: Local critical problems

0 = No problem 1 = Small 2 = Medium 3 = Large

Interviewee

<u>Tool #</u>5

Questionnaire for Community initial data collection

Objectives of the questionnaire:

1) To collect initial data concerning the residents of the community in order to consider the impact on their health and wellbeing that may occur due to the project and what should be done to reduce or prevent those impact.

2) To have the baseline data to compare with those in the construction and operation phases in order to monitoring and evaluation.

However, the HIA team should review this questionnaire before use and adjust or make the correction as need according to the context on the community and project/plan/policy.

The questionnaire is composed of 8 sections.

Section 1: Personal information Section 2: Occupation and workplace Section 3: Health history Section 4: Disease/sign/symptom Section 5: Social data Section 6: Mental health

Section 1: Personal information				
1. Sex (M F); AgeYr; Heightcm.; weightkg.				
2. Status \Box Single \Box Married \Box Dive	orce			
3. Hometown \Box Here \Box Migrant; from.	for yr.			
4. Number of family member (Elde	erly person, Child person)			
5. Religious \Box Buddhism \Box Christ \Box	Islam 🗆 Other			
6. What are thing or place to be proud in you	r province or community?			
7. Are you a member of any association, club	o, organization e.g. elderly club?			
8. The highest education.(
□ Grade 1-6 □ high/- vo	cational Certificate			
□ Grade 7-9 □ Bachelor				
□ Grade 10-12 □ Higher th	nan bachelor			
9. Occupationlike/satisfy your work.(Yes No Moderate)				
Because				
Income (vourself) Baht/month	Eamily income Baht/month			
$\Box < 5,000$ Babt	$\Box < 5.000$ Babt			
\Box 5,000 – 10,000 Baht	\Box 5.000 – 10.000 Baht			
□ 10,000-15,000 Baht	□ 10,000-15,000 Baht			

□ > 15,000 Baht

□ > 15,000 Baht

If you are housewife, have you ever done other work? It was

.....

10. Do you smoke?

 □ No
 □ Yes
 □ Used to smokeyr....month

 Type of cigarette:
 □ cigarette in the market
 □ Homemade. Cigarette/day......

11. Do you drink alcohol?

\square No	\Box Yes	□ Used to drinkyr	1
--------------	------------	-------------------	---

Section 2: Occupation and workplace (if no occupation, go to next section)

1. Work history.(start with the latest one)

Company's name	Work characteristic	Hazard in workplace (Chemicals)	Duration

2. Current job start in (mm/yy).....

Company's	W. I. I. martiniti	Work	Hazard in workplace	Exposure
name	work characteristic	Duration	(Chemicals)	Duration

3. At work, did you always expose to some kind of chemicals or not? If yes what

chemicals?

 \Box No \Box Yes. Chemical

name:....

4. Have you ever have rash or dermatitis which related to occupation? If yes, describe its characteristic.

	No
--	----

 \Box dry and crack/thickening \Box Rash \Box Red & swollen

□ Other.....

5. Have you ever have the following symptom due to work? If yes, it happen when expose to specific chemical or not?

	\Box No	\Box Yes	\Box Chr	onic chough, w	vhen	worked with (chemical name)	
			□ Wh	eezing, when w	vorke	ed with (chemical name)	
			\Box Che	est pain, when	work	ked with (chemical name)	•
			□ Sho	ortness of breat	th, w	hen worked with (chemical name)	
			🗆 Hea	adache, dizzy,	naus	ea, when worked with (chemical name)	
				ep disturbance	, whe	en worked with (chemical name)	
			\Box Los	se memory, wh	nen w	vorked with (chemical name)	
			□ Nev	ver have such s	ympt	tom.	
6.	How de	o you go to	work?		bus	□ Drive car □ Ride motor cycle	
	$\Box 2 rov$	ws mini tru	ıck	□ Walk		□ Other, specify	
Se	ection 3	: Health hi	story				
1.	Have y	you ever be	en admi	tted in the hosp	pital?	?	
	\Box No						
	□ Yes,	, with (nam	e of illn	ess or disease).		when	
2.	Have y	you ever ha	we opera	ation?			
	\square No						
	□ Yes,	due to				when	
3.	Do you	u have to ta	ake any p	oill regularly?			
	\square No						
	□ Yes,	(name of i	medicine	e)			
4.	Do you	u allergic to	o any me	edicine or food	?		
	□ No						
	□ Yes.						
5.	Have t	he doctor e	ever diag	nosis that you	have	e asthma, allergic to dust, sinusitis?	
	□ No						
	□ Yes,	,			•••••		

6. Have the doctor ever diagnosis that you have emphysema, bronchitis, or any other respiratory tract disease?

Emphys	$\square No \square Yes$
Bronchi	tis \Box No \Box Yes
Other re	spiratory tract disease \Box No \Box Yes
7. Do you hav	ve any congenital disease?
\square No	□ Yes
8. Do you hav	ve cancer?
\square No	□ Yes, where
9. Does any y	your next to kin has cancer?
\square No	□ Yes, whowhere
10. Does anyo	one in your family has cancer?
\square No	□ Yes, whowhere
11. Do you h	ave any other health problem
\square No	□ Yes, explain
12. The neare	est health station to your community is
Have you e	ever used their services?
\Box No	\Box Yes. How is the quality of service (\Box Good and fast, \Box Good but delay,
	\Box Moderate but fast \Box Other)
13. Is the hea	Ith care service in your community sufficient?

 \Box Yes \Box No

Section 4: Disease/sign/symptom

	Frequency				Occur while			
Group of symptom		1-3 d/m	1-3	Almost				
	No		d/wk.	everyday	@work	@home	Uncertain	
			Eye symp	otom				
Irritation								
Dry								
teary								
itch								
red								
acrid								
		ľ	Nose symp	ptom		l	I	
Irritation								
Running nose								
Stuffy								
Acrid								
nosebleed								
	•	ľ	Neck sym	ptom	•			
Dry								
Acrid								
Irritation								
Sore								
			CNS					
Headache								
Nausea								
Dizzy								
Body systems not								
coordinated								
Muscle pain and stiff								
Fatigue								
Sleep disturbance								
memory loss								
difficult to								
concentrate								
anxiety /agitation								

Section 5: Social data		
1. If there is a factory (size)	with (number of v	vorkers)
How will you feel?		
□ Satisfy. Because		
□ Not satisfy. Because		
2. In present, do you have traffic j	problem (jam or to many	vehicles) in your community?
\Box No \Box Yes. What time	O Morning & evening	O Noon O All day
The reason of bad traffic:	O Public transportation	O Buses O Trucks
	O Personal car and mot	or cycle
	O Bus for employees	O Others
3. If there is a factory (size	e)and there a	are trucks transport in and
outrounds/day. Do you thin	nk that it will cause traffic	problem or not?
\Box No \Box Yes What time	O Morning & evening	O Noon O All day
The reason of bad traffic:	O Public transportation	O Buses O Trucks
	O Personal car and mot	or cycle
	O Bus for employees	O Others
4. At present, do you have problem	m about road accident or 1	not?
\Box No \Box Yes What time	O Morning & evening	O Noon O All day
Most of the time accident occur	r with:	
	O Pedestrian	O Truck
	O Private car	O Bus
	O Motor cycle	O Public transportation
	O Bus for employees	O Others
Most of the victims are:	O Minor injure	
	O Major injuries or disa	bled
	O Death	

5. If there is a factory (size).....in your community. Do you think that it will cause road accident or not?

\square No	\square Yes What time	O Mornin	g & evening	O Noon	O All day
Most of	the time accidents occ	cur with: C	O Pedestrian	0	Truck
		C	O Private car	0	Bus
		C	O Motor cycle	0	Public transportation
		C	O Bus for empl	oyees O	Others
Most of	the victims are:	C	O Minor injure	0	Major injure or disabled
		C	O Death		

6. At present, do you have too dense of population in your community?

- \Box No \Box Yes Most of the population are: O Thai O Foreigner O Both
- 7. If there is a factory (size).....in your community. Do you think that there will be too crowed? (Employees of the factory may move in the area)

 \Box No \Box Yes Most of the population will be: O Thai O Foreigner O Both

8. At present, robbery is a problem of your community?

 \Box No \Box Yes

9. If there is a factory (size).....in your community, do you think that there will have robbery?

 \Box No \Box Yes

10. At present, prostitution is the problem in your community or not?

 \Box No \Box Yes

If there is a factory (size).....in your community, do you think that there will have prostitution problem or not?

 \Box No \Box Yes

11. At present, drug is the problem in your community or not?

12. If there is a factory (size).....in your community, do you think that there will have drug problem or not?

 \Box No \Box Yes

13. At present, too much and bad smell of garbage and waste is the problem in your community or not?

 \Box No \Box Yes

 $[\]Box$ No \Box Yes

14. If there is a factory (size)in your community, there will be the problem	
with too much and bad smell of garbage and waste or not?	
\Box No \Box Yes	
15. At present, do you have the problem with access to health service system or not?	
\Box No \Box Yes	
16. If there is a factory (size)in your community, do you think that there will b	e
the problem of access to health service system or not?	
\square No \square Yes	
17. At present, do the children in the community have disadvantage in education or not?	
\Box No \Box Yes	
18. If there is a factory (size)in your community, do you think that the children	1
in the community will disadvantage in education or not?	
\Box No \Box Yes	
19. At present, do you face the problem with lacking of utility in your community or not?	
\square No \square Yes	
20. If there is a factory (size)in your community, do you think that the lack of	•
utility will occur or not?	
\square No \square Yes	
21. At present, is there contagious disease problem in your community or not?	
\Box No \Box Yes	
22. If there is a factory (size)in your community, you think that there will have)
contagious disease problem or not?	
\Box No \Box Yes	
23. At present, there is fire, chemical spill, flood, land slide or other natural disaster occur	ĉ
or not?	
\square No \square Yes	
24. If there is a factory (size)in your community, do you think that there will	
have fire, chemical spill, flood, land slide or other natural disaster occur or not?	
\square No \square Yes	

Section 6: Mental health

The followings are questions about your experience within 1 month. Please recall and put $\sqrt{}$ in only one the most correct answer.

	Never	Little	Very	Most
1 Do you satisfy in your life?				
2 Do you feel comfortable?				
3 Do you feel bored, frustrated with the daily life.				
4 Do you feel disappointed in yourself.				
5 Do you feel that your life is suffering.				
6 Can you accept a critical problem if you face one?				
7 Are you sure that you can control your emotions when a critical or serious				
incident occurred?				
8 Are you sure that you can face the terrible events if it happens in your life?				
9 Do you feel sympathy when others are suffering?				
10 Do you feel blessed to help others with problems?				
11 Have you assist others when the opportunity arises?				
12 Do you feel proud of yourself?				
13 Did you feel secured when you are with the family?				
14 If you are serious ill, you believe that your family will take care of you well?				
15 Do your family members love and unite to each other?				

Note 1 - Never means I never had the feeling or disagree with the topic.

- Little means ever had a feeling about it a little, or agree with it a little.

- Very means ever had a feeling about it or agree with it, very much
- Most means ever had a feeling in such matters the most, or agree on most matters.

The scoring rate, divided into 2 groups.

Note 2 Group of the questions and the score.

Group 1; No . 1, 2, 6, 7, 8, 9, 10,	(Group 2; No. 3, 4, 5		
Answer	Score		Answer	Score
Never	0		Never	3
Little	1		Little	2
Very	2		Very	1
Most	3		Most	0

Interpretation: Add score of all questions; the total score is 45 and then interpret as the below:

- 35-45 means better mental health than the general public (Good).
- 28-34 represents the mental health of the general public (Fair)
- ≥ 27 means mental health lower than the general public (Poor).

Source: รสรินทร์ เกรย์, วรชัย ทองไทย และ เรวดี สุวรรณนพแก้า.ความสุขเป็นสากล.พิมพ์ครั้งที่ 1.นครปฐม: สถาบันวิจัยประชากรและสังคม มหาวิทยาลัยมหิดลม, 2553 Institute for Population and Social Research Mahidol University [database on the internet] Thailand.2013 [cited 2013 July 18].Available from: URL: <u>http://www.ipsr.mahidol.ac.th/ipsr/Research/MentalHealth/MH_Questionaire.htm</u>

Tool #6									
	Health impact assessment								
	Health impacts Health Risk Matrix								
Health Hazards	Activities	Risk groups	groups (+) positive	Exp. level /	Impact	Risk	Mitigation measure by the project		
			(-) negative	opportunity	level	level	F J		
		1		-					

Tool #8									
	Control, prevention and monitoring measures								
Heath determinants	Risk level	Monitoring and Evaluation							

Appendix C

Law, Criteria and Standards on Sanitation and Occupational Health

Environmental health in establishment is one of the health determinants for workers and surrounding communities. Therefore, HIA should consider this issue as well. The topics are:

1. Drinking and potable water

Drinking and potable water for workers shall comply with the standard defined by the Administrative Committee of the Project to Provide Clean Water for rural throughout the Kingdom (Table 22). The clean water shall be sufficient for all, i.e. 200 - 400 L/person/day, or provide drinking water at least 1 point for employee less than or equal to 40, and shall be added 1 for every 40 additional workers.

Parameters	Unit	Drinking W, WHO (1984)	Consumed w. in rural*	Tap W.; Dpt. of health (2000)**
1. pH	рН	6.5 - 8.5	6.5 - 8.5	6.5 - 8.5
2. Color	Platinum cobalt	15	15	15
3. Turbidity	NTU	5	10	10
4. TDS	mg/L (ppm)	1,000	1,000	1,000
5. Hardness	mg/L (ppm)	500	300	500
6. Fe	mg/L (ppm)	0.3	0.5	0.5
7. Mn	mg/L (ppm)	0.1	0.3	0.3
8. Cu	mg/L (ppm)	1.0	1.0	1.0
9. Zn	mg/L (ppm)	5.0	5.0	3.0
10. Pb	mg/L (ppm)	0.05	0.05	0.03
11. Cr	mg/L (ppm)	0.05	0.05	0.05
12. Cd	mg/L (ppm)	0.005	0.005	0.003
13. As	mg/L (ppm)	0.05	0.05	0.01
14. Hg	mg/L (ppm)	1.0	1.0	1.0
15. SO ₄	mg/L (ppm)	400	400	250

Table	e 22	Consumed	water	standard	Ι.
Parameters	Unit	Drinking W, WHO (1984)	Consumed w. in rural*	Tap W.; Dpt. of health (2000)**	
-------------------------------	------------	---------------------------	--------------------------	---------------------------------------	
16. Cl	mg/L (ppm)	250	250	250	
17. NO ₃ as N	mg/L (ppm)	10	10	50	
18. F	mg/L (ppm)	1.5	1.0	0.7	
19. Residual Free Chlorine	mg/L (ppm)	-	0.2 - 0.5	0.2 - 0.5 ***	
20. Total Coliform Bacteria	mpm/100 ml	0	10	0	
21. (Fecal Coliform Bacteria)	mpm/100 ml	0	0	0	

Table 22 Consumed water standard.

Note: defined by the Administrative Committee of the Project to Provide Clean Water for rural throughout the Kingdom

** Notification of the Department of Health Re: Quality of tap water B.E. 2543

*** At the end of pipeline 0.2 - 0.5 mg/L, use in the monitoring system for tap water.

2. Food sanitation. *Department of Health, Ministry of Public Health gives the food sanitation standard as the following:*

- 2.1. Place for eating and general area.
 - Clean and tidy
 - Tables and chairs are clean, sturdy, and in order.
 - Good ventilation.
- 2.2. Food preparation and cook area.

- Clean, tidy, and the floor is made of strong, smooth materials and in the good conditions and permanent.

- Has good ventilation so that smell and smoke can be vented well.
- Do not prepare food on the floor.

- Preparation and cook table and wall close to stove shall be made of easy cleaning materials e.g. stainless, tile; all are in good condition and table top should be at least 60 cm. height from the floor.

2.3. Food, water, ice, drinks.

- Food and drink in sealed container shall have table of ingredient.

- Quality of Fresh food e.g. meat, vegetable, fruit, and dry food are good, and stored separately from each other. They should be placed at least 60 cm above the floor or

in the refrigerator. If they are kept in the cool storage room, should be placed at least 30 cm above the floor. Fresh food shall be washed before cook.

- Food and drink in sealed containers shall have good quality and be kept in order on the shelf with the height at least 30 cm.

- Cooked food should be put in clean container with lid and placed at least 60 cm above the floor.

- Should have cabinet with the front door made of glass to keep cooked food.

- Drinking water, drinks and juice must clean and put in clean containers with lids, and drainer or provide a tool with handle for taking it from the container, and also put them above the floor at least 60 cm.

- Ice for drink must clean and keep in clean container with lid and have a tool with handle to take ice from the container. Do not allow to keep any other in the ice box. Keep it at least 60 cm above the floor.

2.4. Utensils and tools.

- Utensils and tools e.g. plates, dishes, forks, spoons etc. shall be made of nonhazardous material e.g. stainless, porcelain, glass, aluminum, white melamine; chopsticks made of wood or plastic shall not be painted.

- Container of the cooking acetic acid, fish sauce, and any sauce shall be made of glass; has lid and stainless or porcelain spoon. Other seasoning must be in clean, easy cleaning container with a lid.

- Utensils and tools shall be cleaned by 2 step method, at least, 1^{st} step clean with soap and 2^{nd} wash twice with clean water or rinse with running water. The cleaning set should be put at least 60 cm above the floor.

- Use at least 2 sinks with good drainage for cleaning the utensils and tools.

- Keep clean plate, dish, bowl, glass, etc. in covered container or grid place above the floor at least 60 cm.

- Spoon, fork, chopsticks put in the clean container with the cover in order and let the handle is up. Put it in the place at least 60 cm above the floor.

- Chopping block must be in good condition, not crack; have one for cooked food separated from un-cooked food; should have mesh cover.

2.5. Waste collecting and waste water:

- Use un-leak garbage can with lid.

- There is good condition duct or groove for draining water from the kitchen to water treatment tank; do not drain the water from the kitchen to public drainage directly.

- There is a sump or tank to trap garbage or fat before drain to water treatment tank.

2.6. Cook and waiter/waitress.

- Wear clean and tiny clothes; wear long sleeves shirt.

- Put on white apron or uniform, the cook must wear cap or hair net.

- Must be healthy, not have communicable and skin disease; cook must have evidence of health check-up in that year.

- Personal hygiene is good e.g. short and clean finger nails, do not smoke while working; do not use hand to pick up cooked food directly.

3. Bath and toilet.

Bath and toilet shall comply with the standard e.g.. stand away from crowded area not more than 50 meters; away from the kitchen at least 30 meter. Bath and toilet shall be separated for male and female indicated by marks. There are sufficient sanitary garbage cans in the female toilets. The number of lavatory and urinate in a building present in Table 23.

Bath and toilet can be separated or in the same room. The characteristic of bath and toilet are:

(1) Built with strong and easy to clean materials.

(2) The height of the room not less than 2.00 meter.

(3) There is opening for ventilation not less than 10% or have enough ventilation fan.

(4) The ground floor of the bath and toilet should have slope at less than 1/100, and the drainage is at the lowest point of the floor.

(5) In case there is the feces drainage pipe, the diameter of the pipe shall not less than 10 cm. and slope not less than 1/10.

(6) There is gas release pipe with the diameter of 2.5 cm, and the height of the pipe should be enough so that the smell will not disturb others.

(7) The urinate shall have deodorize system and should be the one that flush to the waste treatment system.

(8) In case that there are many occupants in many floors, the necessary and appropriateness should be considered in order to select on which floor the toilet should be.

(9) In case that the toilet and bath room are together in the same room, the area in the room shall not be less than 1.5 m^2 ; but in case that they are separated the area of each shall not be less than 0.9 m^2 .

Table 23 Number of bath room and toilet in a building.

	Standard		Toilet		
Type of building			urinate	Bath R	Wash- basin
(1) Residential building	Per building	1	-	1	-
(2) Commercial buildings/row house	(1) Per total area of each unit not exceed 200 m^2	1	-	-	-
	(2) Per total area of each unit exceed 200 m^2	2	1	1	-
	(3) Per each unit for three story building	2	1	1	-
(3) Factory building	(1) Per number of male worker ≤ 15	1	1	1	1
	(2) Per number of female worker ≤ 15	2	-	1	1
	(3) Per number of male worker ≥ 16 but not > 40	2	2	2	2
	(4) Per number of female worker ≥ 16 but not > 40	4	-	2	2
	(5) Per number of male worker ≥ 41 but not > 80	3	3	3	3
	(6) Per number of female worker ≥ 41 but not > 80	6	-	3	3
	Those exceed (5) and (6) shall add 1 more for each of every 50 addition.				
(4)Hotel and temporary rental house.	Per 1 room	1	-	1	1
(5) Condominium	Per 1 unit	1	-	1	1
(6) Dormitory	Per 50 m ² of the building area	1	-	1	1
(9) Office	Per 300 m ² of the building area				
	(1) For male	1	2	-	1
	(2) For female	3	-	-	1
(10) Restaurant, food and drink shop	(1) Per area setting dining table $<30 \text{ m}^2$ or seat < 20 , taking the higher	1	-	-	1

Table 23	Number o	f bath room	and toilet in	a building.
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	building Standard la		Toilet		
Type of building			urinate	Bath R	Wash- basin
	number. (Male & female share)				
	(2) Per area setting dining table >30 but not exceed 45 m ² or seat ≥ 20	1	1	-	1
	but not exceed 30, taking the higher number. (Male & female share)				
	(3) Per area setting dining table >45 but not exceed 75 m ² or seat \ge 31				
	but not exceed 50, taking the higher number.				
	(a) For male				
	(b) For female	1	1	-	1
	(4) Per area setting dining table >75 but not exceed 105 m ² or seat \ge 51	2	-	-	1
	but not exceed 70, taking the higher number.				
	(a) For male				
	(b) For female				
	(5) Per area setting dining table >105 but not exceed 150 m ² or seat \geq	2	2	-	2
	71 but not exceed 100, taking the higher number.	4	-	-	2
	(a) For male				
	(b) For female				
	Those exceed (5) add 1 for male and 1 for female for each of every 150	3	3	-	3
	m ² addition, or every 100 seat addition, taking the higher number.	6	-	-	3
(11) Commercial building	(1) Per 200 m ² of building area, for male; the area exceed 2000 m ² shall	1	2	-	1

Table 23	Number of	of bath ro	om and	toilet in	a building.
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	Standard		Toilet		
Type of building			urinate	Bath R	Wash- basin
	 have 1 lavatory, 2 urinate and 1 wash-basin for each 600 m². (2) Per 200 m² of building area, for female; the area exceed 2000 m² shall have 2 lavatory and 1 wash-basin for each 600 m². 	3	-	-	1
(12) Cargo	Per 5,000 m2 building area (1) Male (2) Female	1 2	1 -	-	1 1
(18) Market	(1) Per $\leq 100 \text{ m}^2$ of stall or not more than 50 stalls, taking the higher number.		_		
	 (a) Male (b) Female (2) Per > 100 m² but not exceed 200 m² of stall or >50 stalls not more 	1 2	-	-	l (share)
	than 100, taking the higher number.(a) Male(b) Female	2 4	2	-	1
	 (3) Per > 200 m² but not exceed 400 m² of stall or >100 stalls not more than 200, taking the higher number. (a) Male 				1
	(b) Female	3	3	-	1

Table 23	Number of	of bath room	and toilet in	a building.
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			Toilet		
Type of building Standard		lavatory	urinate	Bath R	Wash- basin
	(4) Per > 400 m ² but not exceed 600 m ² of stall or >200 stalls not more	6	-	-	
	than 300, taking the higher number.				
	(a) Male				2
	(b) Female	4	4	-	2
	(5) Per > 600 m ² but not exceed 1000 m ² of stall or >300 stalls not	8	-	-	
	more than 500, taking the higher number.				
	(a) Male				
	(b) Female				2
	(6) Per > 1000 m ² but not exceed 2000 m ² of stall or >500 stalls not	5	5	-	2
	more than 1000, taking the higher number.	10	-	-	
	(a) Male				
	(b) Female	7			
	Those exceed (6) add 1 lavatory and 1 urinate for male and 2 lavatories	14			3
	for female for each of every 400 m^2 addition, or every 200 stalls		7	-	3
	addition, and 1 wash-basin per every 1000 m2 or every 500 stalls.		-	-	
(20) Temporary building used as workers'	(1) Per 15 male workers or occupants.	1	-	1	1
shelter or others similar to these.	(2) Per 15 female workers or occupants.	1	-	1	1
	(3) Per \geq 16 but not more than 40 male workers or occupants.				

Table 23	Number of	f bath room	and toilet	in a building.
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	building Standard		Toilet		
Type of building			urinate	Bath R	Wash- basin
	(4) Per \geq 16 but not more than 40 female workers or occupants.	2	-	2	1
	(5) Per \geq 41 but not more than 80 male workers or occupants.				
	(6) Per \geq 41 but not more than 80 female workers or occupants.	2	-	2	1
	Those exceed (5) and (6) shall add 1 more for each of every 50 workers				
	or occupants addition.	3	-	3	1
		3	-	3	1
(21) Other besides (1)-(20) in where employee	(1) Per ≤15 male	2	1	1	1
live.	(2) Per ≤ 15 female	3	-	1	1
	(3) Per ≥ 16 male but not more than 40.	2	2	2	2
	(4) Per ≥ 16 female but not more than 40.	4	-	2	2
	(5) Per \geq 41 male but not more than 80.	3		3	3
	(6) Per \geq 41 female but not more than 80.	6		3	3
	Those exceed (5) and (6) shall add 1 more for each of every 50				
	employees addition.				

Source: The ministerial regulations, No. 39 (B.E. 2537) and No. 63 (B.E. 2551) Issued under the building control law.

4. Noise

Noise level	Measurement method
1. The maximum level	1. The sound level meter is used to measure the maximum noise
shall not exceed 115	level in where the occupant live or stay.
dBA	2. To measure the average noise level for 24 hrs, the sound level
	meter shall be used to measure continuously for any 24 hours.
2. Average in 24 hrs.	3. The measurement outdoor: set microphone above the ground at
shall not exceed 70	least 1.2 meter; in the horizontal radius of 3.5 meter of the
dBA.	microphone shall not have wall or any material that may reflect the
	noise.
	4. The measurement indoor: set microphone above the ground at
	least 1.2 meter; in the horizontal radius of 1 meter of the microphone
	shall not have wall or any material that may reflect the noise, and
	shall be set away from the window or open wall.

 Table 24 Noise level standard

Source: 1. Notification of the National Environmental Board, Issue 15 (B.E. 2540), Re: Standardize the general noise level, section 32 (5) of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992) as of March 12 1997

2. Notification of the Pollution Control Committee, Re: Measurement method of background noise when there is no distraction; measurement and calculation of .the interference and record form for annoyance noise, issue on 31 August 2550 (B.E.)

3. Notification of Pollution Control Department. Re: Calculation of noise level, issue on 11 August B.E. 2540

Standard	Measurement of background and interfere noise
The different	1. Interfere noise continue for \geq 1 hr shall measure the L _{eq 1 hr}
between	2. Interfere noise continue for < 1 hr shall measure only the
background	interfere period.
(L_{90}) and	3. The interfere is not continuous noise; occurs more than 1 periods
interfere noise =	which less than 1 hr, measure noise in every periods for 1 hr.
10 dBA is	4. In case of the place needed to be quiet e.g. hospital, school and/or
interfere level.	interfering noise occur between 22.00-06.00 hr., measure L_{eq5min}
	and add up with 3 dBA.

 Table 25 Noise level standard.

Source: 1. Notification of the National Environmental Board, Issue 29 (B.E. 2550) Re: Interfering noise level.

Table 26 Noise level in workplace.

Exposure duration (Hr)	Noise level (TWA) (dBA)
12	89
8	90
7	91
6	92
5	93
4	95
3	97
2	100
1 1/2	102
1	105
1/2	110
1/4 or less	115

Source: Ministerial Regulation. Set standard for the Administration and Management of Occupational Health, Safety and Environment on heat, Light, and noise. 2549 B.E.

5. Air pollution.

 Table 27 Monitoring concentration limit for VOC in ambient in 24 hours.

Pollutants	Standard
1. Acetaldehyde	Not exceed 860 μ g/m ³
2. Acrylonitrile	Not exceed 10 μ g/m ³
3. Benzene	Not exceed 7.6 μ g/m ³
4. Benzyl Chloride	Not exceed 12 μ g/m ³
5. 1,3-Butadiene	Not exceed 5.3 μ g/m ³
6. Bromomethane	Not exceed 190 µg/m ³
7. Carbon Tetrachloride	Not exceed 150 μ g/m ³
8. Chloroform	Not exceed 57 $\mu\mu g/m^3$
9. 1,2-Dibromoethane	Not exceed 370 μ g/m ³
10. 1,4-Dichlorobenzene	Not exceed 1100 μ g/m ³
11. 1,2-Dichloroethane	Not exceed 48 μ g/m ³
12. Dichloromethane	Not exceed 210 μ g/m ³
13. 1,2-Dichloropropane	Not exceed 82 μ g/m ³
14. 1,4-Dioxane	Not exceed 860 μ g/m ³
15. (2-Propenal/acrolein	Not exceed 0.55 μ g/m ³
16. Tetrachloroethylene	Not exceed 400 μ g/m ³
17. 1,1,2,2-Tetrachloroethane	Not exceed 83 μ g/m ³
18. Trichloroethylene	Not exceed 130 μ g/m ³
19. Vinyl Chloride	Not exceed 20 μ g/m ³

Source: Notification of the Pollution Control Department Re: Monitoring concentration limit for VOC in ambient in 24 hours.

Notification of the Ministry of Natural Resource and Environment Re: The industrial factory is the pollution sources to be controlled the emissions to the atmosphere. According to this notification the factory type 2 and 3 are defined as the generation sources of pollutants which shall be controlled the emission and the emission shall be complied with the standard in Table 28.

Substances	Sources	Non Combustion*	Combustion**	
1. Particulate	1. Boiler and Furnace			
$(in mg/m^3)$	– Fuel Oil	-	Not exceed 240	
	– Coal	-	Not exceed320	
	– Biomass	-	Not exceed 320	
	– Other Fuel	-	Not exceed 320	
	2. Steel and Aluminum	Not exceed 300	Not exceed 240	
	mfg.			
	3. Any Source	Not exceed 400	Not exceed 320	
2. Sulfur Dioxide	1. Boiler and Furnace			
(in ppm)	– Fuel Oil	-	Not exceed 950	
	– Coal	-	Not exceed 700	
	– Biomass	-	Not exceed 60	
	– Other Fuel	-	Not exceed 60	
	2. Any Source	Not exceed 500	-	
3. Oxides of	Boiler and Furnace			
Nitrogen	– Fuel Oil	-	Not exceed 200	
(in ppm)	– Coal	-	Not exceed 400	
	– Biomass	-	Not exceed 200	
	– Other Fuel	-	Not exceed 200	
4. Carbon				
Monoxide	Any Source	Not exceed 870	Not exceed 690	
(in ppm)				
5. Hydrogen				
Sulfide	Any Source	Not exceed 100	Not exceed 80	
(in ppm)				
6. Hydrogen				
Chloride	Any Source	Not exceed 200	Not exceed 160	
$(in mg/m^3)$				
7. Sulfuric Acid	Sulfuric Acid	Not exceed 25		
(in ppm)	Production	1101 UACOUU 25		

 Table 28 Industrial air emission standard.

Substances	Sources	Non Combustion*	Combustion**	
8. Xylene	Any Source	Not exceed 200	-	
(in ppm)				
9. Cresol	Any Source	Not exceed 5	-	
(in ppm)	They Source			
10. Antimony	Any Source	Not exceed 20	Not exceed16	
$(in mg/m^3)$	Any Source	Not exceed 20	NOT EXCECUTO	
11. Arsenic	Any Source	Not exceed 20	Not exceed16	
$(in mg/m^3)$	Any Source	Not exceed 20		
12. Copper	Any Source	Not exceed 30	Not exceed 24	
$(in mg/m^3)$	Any Source	Not exceed 50		
13. Lead	Any Source	Not exceed 30	Not exceed 24	
(in mg/m ³)	They Source	Not exceed 50		
14. Chlorine	Any Source	Not exceed 30	Not exceed24	
$(in mg/m^3)$	Any Source			
15. Mercury	Any Source	Not exceed 3	Not exceed 2.4	
$(in mg/m^3)$	Any Source			

 Table 28 Industrial air emission standard.

Remark: * Reference condition is 25 °C at 1 atm or 760 mmHg, Dry Basis.

** Reference condition is 25 & C at 1 atm or 760 mmHg, at O2 of 7 % and Dry Basis

- Source: 1. Notification of the Ministry of Natural Resources and Environment B.E. 2549 (2006), issue under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) dated April 5, B.E. 2549(2006), and published in the Royal Goverment Gazette, Vol 123, Part 50D dated May 18, B.E. 2549 (2006)
 - Notification of the Ministry of Natural Resources and Environment B.E. 2549 (2006), issue under the Enhancement and Conservation of National Environmental Quality Act B.E. 2535 (1992) dated April 5, B.E. 2549(2006), and published in the Royal Goverment Gazette, Vol 123, Part 50D dated May 18, B.E. 2549 (2006)

6. Light

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 Table 29 Average illumination intensity in general workplace

Industry	Building/Area	Intensity (Lux)
General area of the	Entrance	200
building		
	- Entrance to the lobby	400
	- Public relation desk or front desk	50
	- Gate of the factory	100
	- Security guard at goods transfer point	100
	Traffic areas	
	- Walkway, less travel	20
	- Walkway, more travel	50
	- Stairway	50
	Lecture and training room	
	- General area	300
	Computer room	
	- General area	400
	meeting room	300
	Administrative room	
	- Copy room	300
	- Security room	100
	Canteen	
	- General area	200
	- Cashier	300
	Staff rest room	
	- Locker and changing room	100
	- Rest room	50

Industry	Building/Area	Intensity (Lux)
	First aid room	
	- Recovery room	50
	- Medical examination room	400
	Toilet	100
	Storage room	
	Large Stock/warehouse	
	: Keep for long time	50
	: Store waiting for transfer	100
	Medium Stock/warehouse or sensitive	
	: Keep for long time	100
	: Store waiting for transfer	200

Table 29 Average illumination	n intensity in general	workplace
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Source: Ministerial Regulation. Set standard for the Administration and Management of Occupational Health, Safety and Environment on heat, Light, and noise. 2549 B.E.

Table 30 Average illumination intensity in general workplace of the chemical factory (enamel factory)

Industry	Building/Area	Intensity (Lux)
Chemical industry	Paint factory	
	- General automatic machine	200
	- Mixing special color	600
	- Comparison of the color	800

Source: Ministerial Regulation. Set standard for the Administration and Management of Occupational Health, Safety and Environment on heat, Light, and noise. 2549 B.E.

7. Heat

Table 31 WBGT in workplace.

Work load	WBGT (⁰ C)
Light	34
Moderate	32
Heavy	30

Source: Ministerial Regulation. Set standard for the Administration and Management of Occupational Health, Safety and Environment on heat, Light, and noise. 2549 B.E.

8. Vibration.

TLV for vibration recommended by ACGIH presented in Table 33 and 34.

Table 32 Acceleration of vibration in longitudinal (az) (Foot to had). TLV in RMS of the vibration at one frequency or RMS of the vibration distribute in 1/3 Octave band (Adjusted from ISA 2631)

Freq.	-			Accel	eration (m/	s ²)			
(Hz)				Expo	sure duration	on			
	24 hrs.	16 hrs.	8 hrs.	4 hrs.	2.5 hrs.	1 hrs.	25 min	16 min	1 min
1.0	0.280	0.383	0.63	1.06	1.40	2.36	3.55	4.25	5.60
1.25	0.250	0.338	0.56	0.95	1.26	2.12	3.15	3.75	5.00
1.6	0.224	0.302	0.50	0.85	1.12	1.90	2.80	3.35	4.50
2.0	0.200	0.270	0.45	0.75	1.00	1.70	2.50	3.00	4.00
2.5	0.180	0.239	0.40	0.67	0.90	1.50	2.24	2.65	3.55
3.15	0.160	0.212	0.355	0.60	0.80	1.32	2.00	2.35	3.15
4.0	0.140	0.192	0.315	0.53	0.71	1.18	1.80	2.12	2.80
5.0	0.140	0.192	0.315	0.53	0.71	1.18	1.80	2.12	2.80
6.3	0.140	0.192	0.315	0.53	0.71	1.18	1.80	2.12	2.80
8.0	0.140	0.192	0.315	0.53	0.71	1.18	1.80	2.12	2.80
10.0	0.180	0.239	0.40	0.67	0.90	1.50	2.24	2.65	3.55
12.5	0.224	0.302	0.50	0.85	1.12	1.90	2.80	3.35	4.50
16.0	0.280	0.383	0.63	1.06	1.40	2.36	3.55	4.25	5.60
20.0	0.355	0.477	0.80	1.32	1.80	3.00	4.50	5.30	7.10
25.0	0.450	0.605	1.0	1.70	2.24	3.75	5.60	6.70	9.00
31.5	0.560	0.765	1.25	2.12	2.80	4.75	7.10	8.50	11.2
40.0	0.710	0.955	1.60	2.65	3.55	6.00	9.00	10.6	14.2
50.0	0.900	1.19	2.0	3.35	4.50	7.50	11.2	13.2	18.0
63.0	1.120	1.53	2.5	4.25	5.60	9.50	14.0	17.0	22.4
80.0	1.400	1.91	3.15	5.30	7.10	11.8	18.0	21.2	28.0

Freq.				Acc	eleration (m/s^2)			
(Hz)	24 hrs.	16 hrs.	8 hrs.	4 hrs.	2.5 hrs.	1 hrs.	25 min	16 min	1 min
1.0	0.100	0.135	0.224	0.355	0.50	0.85	1.25	1.50	2.0
1.25	0.100	0.135	0.224	0.355	0.50	0.85	1.25	1.50	2.0
1.6	0.100	0.135	0.224	0.355	0.50	0.85	1.25	1.50	2.0
2.0	0.100	0.135	0.224	0.355	0.50	0.85	1.25	1.50	2.0
2.5	0.125	0.171	0.280	0.450	0.63	1.06	1.6	1.9	2.5
3.15	0.160	0.212	0.355	0.560	0.80	1.32	2.0	2.36	3.15
4.0	0.200	0.270	0.450	0.710	1.0	1.70	2.5	3.0	4.0
5.0	0.250	0.338	0.560	0.900	1.25	2.12	3.15	3.75	5.0
6.3	0.315	0.428	0.710	1.12	1.6	2.65	4.0	4.75	6.3
8.0	0.40	0.54	0.900	1.40	2.0	3.35	5.0	6.0	8.0
10.0	0.50	0.675	1.12	1.80	2.5	4.25	6.3	7.5	10.0
12.5	0.63	0.855	1.40	2.24	3.15	5.30	8.0	9.5	12.5
16.0	0.80	1.06	1.80	2.80	4.0	6.70	10.0	11.8	16.0
20.0	1.00	1.35	2.24	3.55	5.0	8.5	12.5	15.0	20.0
25.0	1.25	1.71	2.80	4.50	6.3	10.6	15.0	19.0	25.0
31.5	1.60	2.12	3.55	5.60	8.0	13.2	20.0	23.6	31.5
40.0	2.00	2.70	4.50	7.10	10.0	17.0	25.0	30.0	40.0
50.0	2.50	3.38	5.60	9.00	12.5	21.2	31.5	37.5	50.0
63.0	3.15	4.28	7.10	11.2	16.0	26.5	40.0	45.7	63.0
80.0	4.00	5.4	9.00	14.0	20.0	33.5	50.0	60.0	80.0

Table 33 Acceleration of vibration in horizontal (a_x or a_y) (Back to chest or left to right). TLV in RMS of the vibration distribute in 1/3 Octave band (Adjusted from ISA 2631)

9. Hazard waste

Notification of the Ministry of Industry: the Disposal of waste and non-use, 2548 B.E. defines "hazardous waste" means waste having hazardous constituents, being contaminated with hazardous substance, or having hazardous characteristics; and shall treated as the following:

9.1 One who appoints a representative and a representative itself shall have liability while waste transportation is in progress and shall assure that its waste collector and transporter shall proceed as follows:

9.1.1 An operation must be in compliance with the Ministerial Notification regarding hazardous waste manifest system B.E. 2547 (2004).

9.1.2 An operation must be in compliance with the Notification of Hazardous Substance Committee Resolution regarding land transportation of hazardous substance B.E. 2545 (2002).

9.1.3 A waste collector and transporter shall submit an annual report to Department of Industrial Works using the Form SoKo.4 annexed to this Ministerial Notification by the first date of March of the following year.

9.2 A waste processor shall establish an emergency response plan in case there is a spill, fire, explosion of wastes, or accident as prescribed in Annex 3 annexed to this Ministerial Notification. A waste processor shall assure that in a factory there is safety equipment, emergency mitigation equipment and evacuation route.

An emergency plan and an emergency response plan, at minimum, shall consist of the following detail:

9.2.1 Procedural step in implementation in response to fire, explosion or unexpected accident including spill and leakage of hazardous waste or its component.

9.2.2 Cooperation with local authority such as Tambon administrative organization, police station, fire fighter station, hospital and rescue unit, etc. to assist and cooperate during an emergency.

9.2.3 There shall be a list of name address and phone number (home and office) of responsible personnel and facilitator during an emergency and this list must be updated. If there are several responsible persons, name list should be in order of responsibility that is a person with direct responsibility should be on top of the list.

9.2.4 There shall be a list of safety equipment and emergency equipment in a facility (such as fire fighter system, spill kit, communication and warning system (both outside and inside) and decontamination equipment) including specific information on storage location for such equipment and detailed description of how to use these equipment.

9.2.5 There shall be an evacuation plan for worker of such facility if necessary. The plan should describe a sign or signal that will be used in prompting an evacuation, evacuation route and alternative route (in case there is leakage and fire in the main route) 9.3 Information, copy of plan and operating procedure should be available for local police station, fire fighter station, hospital and rescue unit in order to respond to emergency quickly and properly.

9.4 After an accident or an emergency, operating procedure for treatment, storage or disposal of waste arisen from such event, and remediation plan should be prepared. In case there is contamination of hazardous waste to the environment, preventive maintenance plan shall be established to determine flawed point, malfunction, mistake during implementation and spill or leakage of hazardous substance which leads to the environment and potentially harmful to human and the environment.

The hazardous waste management is under several organizations as presented in Table 34.

Organization	Responsibility
The Ministry of Natural resource and	- Response for set up plan and enforce the regulation
Environment.	concerning hazardous waste including hazardous waste
- Office of Natural Resources and	from the community.
Environmental Policy and Plan	- Set up policy and plan for promotion and reservation
- Pollution Control Department	of the quality of environment; setting up policy,
- Environmental Promotion Department	standard, research, coordination, education and
	community relation.
Ministry of Interia	- Responsible for community garbage and cleaning in
- Department of Local Administration	case of chemical spill emergency.
- Department of Disaster Prevention and	- Work and coordinate on the community's financial
Mitigation.	management.
Ministry of Public Health	- Response for public and occupational health, and has
- Department of Health	authority to control and supervise hospital throughout
	the country.
	- Authorize the local governmental office to storage
	and disposal infectious waste including collect fee as
	defined in the Public Health Act B.E. 2535.
Ministry of Industry	- Control the practice of the factory on hazardous waste
- Department of Industrial Work	management.
	- Control and inspect the practice as defined by the

 Table 34 Responsible organization for hazardous waste.

Organization	Responsibility	
	regulation under the Hazardous Substances B.E. 2535	
	which control all kind of hazardous waste.	
Ministry of Education	- Control, inspect and study hazards occur in or arise	
	from the university's laboratory.	
Ministry of Transportation	- Control and inspect sea waste which mostly are	
	lubricants and different kind of oils from the activities	
	of sea transportation and jetty.	
Ministry of Agriculture and	- Control the use and storage of pesticide and weeds.	
Cooperatives		
- Department of Agriculture		

 Table 34 Responsible organization for hazardous waste.

10 Waste and non-use

According to the Notification of the ministry of Industry regards Industrial Waste Disposal B.E. 2548, "waste and non-use" means unusable materials or all types of wastes generated from industrial activity including wastes from raw material, wastes generated from production process, products that are deteriorated in quality, and effluent having hazardous constituents or hazardous characteristics.

Waste generator shall:

10.1 Have waste in possession within a factory premise no longer than the period of 90 days. If the time in possession is longer than that prescribed, a waste generator shall ask permission from Department of Industrial Works using the Form SoKo.1 annexed to this Ministerial Notification. In case of having hazardous waste in possession, a waste generator shall be in compliance with the provisions of the Ministerial Notification regarding hazardous waste manifest system B.E. 2547 (2004).

10.2 Shall assure that there is a supervisor with certain expertise of pollution control system as required in a factory in accordance with the Ministerial Notification regarding descriptions of factory types and sizes, procedure for the control of Discharges of wastes, pollutants, or any substances that cause adverse effects on the environment, qualifications of supervisors and operators, and criteria for registration of the supervisors of pollution

prevention systems B.E. 2545 (2002), and shall conduct a training for responsible employees so they can perform their job in a properly and safely manner.

10.3 Shall establish an emergency response plan in case there is a spill, fire, explosion of wastes, or accident as prescribed in Annex 3 annexed to this Ministerial Notification. A waste generator shall assure that in a factory there is safety equipment, emergency mitigation equipment and evacuation route.

10.4 It is not allowed to transport waste out of factory premise unless permission is granted from Director-General of Department of Industrial Works or from an authorized person to manage wastes with method and location according to criteria and procedure prescribed in Annex 4 annexed to this Ministerial Notification. For waste treatment or disposal in factory premise, it must be done in accordance with those prescribed in Chapter 4 Article 17 and Article 21-24 of the regards Industrial Waste Disposal B.E. 2548 as well; and shall comply with the following.

10.4.1 Landfill: There shall be lining system, leakage detection system, gas ventilation system, and leachate treatment system appropriate for type and characteristic of wastes without adverse effect on the environment, also must be approved from Department of Industrial Works.

10.4.2 Incineration of non-hazardous waste shall be done so that stack emission is in compliance with the Notification of Ministry of Science Technology and Environment regarding emission standard for solid waste incinerator dated 17th June B.E. 2540 (1997). Incineration of hazardous waste is not allowed unless it is approved by Department of Industrial Works.

10.4.3 Other management methods such as composting, land reclamation, recycle shall be approved by Department of Industrial Works.

10.5 A waste generator shall send off its hazardous waste to waste collector and transporter or waste processor only, otherwise approval from Department of Industrial Works must be granted.

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10.6 Manifest sheet shall be used every time hazardous waste is transported out of factory premise. A waste generator also has to report transport of all wastes under this Notification to Department of Industrial Works by reporting via the internet.

10.7 A waste generator shall inspect its waste and be liable for its loss, accident, illegal dumping and return due to any dispute in the service agreement between waste generator and waste processor until waste processor agrees to accept such waste in possession

10.8 A waste generator shall submit an annual report to Department of Industrial Works using the Form SoKo.3 annexed to this Ministerial Notification by the first date of March of the following year.

10.9 Import or export of waste into or out of the Kingdom shall be done in accordance with the law governing associated matter and international laws.

9. Water waste management

Mostly industrial waste water comes from production process and washing thus contains chemicals from the process. Therefore, before draining to the reservoir, treatment is needed to keep the quality of waste water as defined by the standard issued by the Ministry of Industry, No 2 (2539 B.E.) (Table 36). The factory with waste water exceed 10,000 m³/day and those with \geq 3,000 m³/day to 10,000 m³/day, or those with BOD load in the influent \geq 4,000 kg/day must install equipment or special equipment to report the effluent. This equipment must be connected to the computer network of the Ministry of Industry, Except, in case that the factory does not drain the waste water out of the factory, but drain to the Central Waste Treatment Plant.

Table 35 Standard for waste water from industrial factory and industrial estate.	

Parameter	Standard	Analysis method
1. pH	5.5-9.0	pH Meter
2. TDS (Total Dissolved Solids)	Not exceed 3000 mg/L, or depend on type of reservoir or type of factory according to the Pollution Control Committee's	Dry out at 103- 105 ∜C for 1 hour.

Parameter	Standard	Analysis method
	issues but not exceed 5000 mg/L. Waste	
	water draining to brackish water whose	
	saltiness exceed 2,000 mg/L or to the sea,	
	TDS in waste water shall not be higher	
	than those in the brackish water and in the	
	sea than 5,000 mg/L	
	Not exceed 50 mg/L, or depend on type	Filtration using
2 Suspended Solids	of reservoir or type of factory according	Class Eiber Eilter
5. Suspended Sonds	to the Pollution Control Committee's	Diag
	issues but not exceed 150 mg/L	Disc
		Thermometer while
4. Temperature	Not exceed 40 ೆC	taking water
		sample.
5. Color and odor	Must not be disgusting.	Not specified
6. Sulfide as H ₂ S	Not exceed 1.0 mg/L	Titrate
		Distillation and
7. Cyanide as HCN	Not exceed 0.2 mg/L	Pyridine Barbituric
		Acid
	Not exceed 5.0 mg/L or depend on type	Extraction using
	of reservoir or type of factory according	solvent and
8. Fat, Oil and Grease	to the Pollution Control Committee's	separate then
	issues but not exceed 15 mg/I	weight Fat, Oil and
	issues but not exceed 15 mg/L	Grease
9. Formaldehyde	Not exceed 1.0 mg/L	Spectrophotometry
10 Phenols	Not exceed 1.0 mg/I	Distillation and use
10.1 nenois		4-Aminoantipyrine
10. Free Chlorine	Not exceed 1.0 mg/L	lodometric Method
12 Pesticide	Not detect, when using the specified	Gas-
	method	Chromatography
13. Biochemical Oxygen	Not exceed 20 mg/L, or depend on type	
Demand (BOD) (5 days at	of reservoir or type of factory according	Azide Modification
20 °C	to the Pollution Control Committee's	at 20 °C for 5 days.
	issues but not exceed 60 mg/L	

Table 35 Standard for waste water from industrial factory and industrial estate.

Parameter	Parameter Standard		
	Not exceed 100 mg/L or depend on type		
14. TKN (Total Kjeldahl	of reservoir or type of factory according	<i>V</i> ioldobl	
Nitrogen)	to the Pollution Control Committee's	Kjeldalli	
	issues but not exceed 200 mg/L		
15 Chamberl Orena Damant	Not exceed 120 mg/L or depend on type	Potassium	
15. Chemical Oxygen Demand	of reservoir or type of factory according	Dichromate	
: COD)	to the Pollution Control Committee's	Digestion	
	issues but not exceed 400 mg/L		
16. Heavy Metal		Atomic Absorption	
1. Zinc (Zn)	Not exceed 5.0 mg./L.	Spectro	
2. Hexavalent Chromium	Not exceed 0.25 mg./L.	Photometry, type	
3. Trivalent Chromium	Not exceed 0.75 mg./L.	Direct Aspiration	
4. Copper (Cu)	Not exceed 2.0 mg./L.	or Plasma Emission	
5. Cadmium (Cd)	Not exceed 0.03 mg./L.	Spectroscopy, type Inductively Coupled Plasma: ICP	
6. Barium (Ba)	Not exceed 1.0 mg./L.		
7. Lead (Pb)	Not exceed 0.2 mg./L.		
8. Nickle (Ni)	Not exceed 1.0 mg./L.		
9. Manganese(Mn)	Not exceed 5.0 mg./L.		
10. Arsenic (As)	Not exceed 0.25 mg./L.	Atomic Absorption	
		Spectrophotometry,	
	Not exceed 0.02 mg./L.	type Hydride	
		Generation or	
11. Selenium (Se)		Plasma Emission	
		Spectroscopy, type	
		Inductively Coupled	
		Plasma : ICP	
		Atomic Absorption	
12. Mercury(Hg)	Not exceed 0.005 mg./L.	Cold Vapor	
		Techique	

Table 35 Standard for waste water from industrial factory and industrial estate.

Source: Notification of the Ministry of Science, Technology and Environment, No. 3 (2539): Define the standard to waste water from the factory and industrial estate.

Appendix E Example of risk management

Risk level					
Acceptable	Low	Moderate	High	Very high	
				Elimination	
				Substitute or use	
				lower risk	
				alternative	
				method.	
			PPE and have pla	an for engineering	
			control.		
		Control by standard operating procedure, training,			
		and engineering control (if possible).			
		PPE. This method only reduce the exposure, but does			
		not reduce hazard.			
	Monitor and surveillance				
	Exposure assessment using industrial hygiene equipment. Every level				
	must have environmental monitoring, but the frequency depends on the				
	risk level.				
	Training.				

Source: Ministry of Industry Notification, No. 4439 (B.E. 2555), issued under the Industrial Product Standard Atc B.E. 2511: Health Risk Assessment of the industrial workers.