Global Power Synergy Public Company Limited	**Corporate Procedure**

Latest Revision Document Information

Doc. No.	HES-CP-0018	Business Unit (Function)	COO	Dept./Div	HES
Doc. Title	Health Risk Assessment			Status	-
Revision	01	Release Date	18 August 2021	Page	1 - 29
Softcopy Location:	• GPSC Corporate Document Management System (CDMS) / HES / Procedure				

Reference System / Standards and Requirements

No.	System / Standards	Requirements

Related Document

No.	Document Type	Document No.	Document Name	Release Date
1	Form	HES-F-0002	Occupational hazard exposure record form	18 August 2021
2	Form	HES-F-0003	Form for recording and screening for SEGs classification in each department	18 August 2021
3	Form	HES-F-0004	Hazard identification and Heath risk assessment form	18 August 2021

DOCUMENT CONTROL FLOW:

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Distribution:

The following table lists the distribution of this document. (and new Revisions of this document)

No.	Department	Format
1	All Department	CDMS

DOCUMENT EDITING RECORDS:

The following table presents the change record of this document.

Revision No.	DAR No.	Owner / Requestor	Change Details	Release Date
00	63-HES-009	Satiya Angkaprasertkun Soraya Raemwanith	Due to a change in the organizational structure Therefore documents have been updated to cover both GPSC and GLOW.	15 July 20
01	DAR-2021-00853	Satiya Angkaprasertkun Soraya Raemwanith	Change to standard format (Ref SQM-CP-0001)	18 August 2021

RELATED DEPARTMENT / DIVISION (Implementation areas):

The following are the departments involved in the implementation.

No.	Department	Initial

1. TRAINING INFORMATION

[ ]	No need training	Reason	
[×]	Training required	Dept./Div.	All

Table of Contents

1. OBJECTIVES

To be used as guidelines for health risk identification and assessment in the working environment to define risks pursuant to job characteristics. Assessment results will be used to develop the correct, complete and up-to-date health risks control and measurement system

2. SCOPE

This procedure covers all activities and working environments which have health effects under business operations of Global Power Synergy Public Company Limited Group (GPSC Group).

3. TERMS AND DEFINITIONS

Term	Definition
Health Risk Assessment (HRA)	Estimation of probability or opportunity that the health of operators who expose to risk-related works will be impacted from such exposure.
Risk Factors	Tasks performed by the employees which related to: - Hazardous chemicals as per specified by the Minister. - Toxic microbe which may be virus, bacteria, fungus or other biological substance - Radioactivity - Physical properties, such as heat, cold, vibration, pressure, atmosphere, light, noise or environment conditions which may be harmful.
Similar Exposure Group (SEGs)	Group of workers having the same general exposure profile because of similarity of risk factors and frequency of the tasks they perform (such risk factors mean raw materials or chemicals, production process and working method). One worker may be in many SEGs groups.
Fitness for work	The employees' health must fit for work characteristics. Health check-up pursuant to risks exposed by the employees during operation will be undertaken.
Biological Monitoring	Monitoring of determinant in biological samples collected from the employee during the specified period of time. Biological Exposure Indices (BEIs) will be used as reference values.

Biological Exposure Indices (BEIs)	Level of determinant which has tendency to be detected in samples collected from healthy operators who exposed to substance which has intensity level equal to Occupational Exposure Limit (OEL). Biological monitoring will indirectly identify amount of substance exposed.
Occupational Exposure Limit (OEL)	Concentration level of hazardous chemical in the workplace that most of the operators exposed 8 hours a day, 5 days a week, without having any health impact.

Term	Definition
Occupational Exposure Limit-Time-Weighted Average (TWA, OEL-TWA)	Concentration of hazardous substance in the air averaged over 8 hours per day and 5 days per week that workers may be repeatedly exposed, without adverse effects.
Short-Term Exposure Limit (STEL or OEL-STEL)	Average concentration of chemicals that the employee can be exposed to not more than 4 times a day, each not exceeding 15 minutes and with a minimal interval of 1 hour. Total average concentration exposed must not exceed OEL-TWA.
Occupational Exposure Limit – Ceiling (C or OEL-C)	Concentration of chemical or hazard in air that should not be exceeded at any time.
Wet Bulb Globe Temperature (WBGT)	(1) Temperature, in degree Celsius, which is measured outside of the building without sunlight, or in the building of which has heat level equal to 0.7 time of temperature read from natural wet bulb thermometer plus 0.3 time of temperature read from Globe Thermometer; or (2) Temperature, in degree Celsius, which is measured outside of the building with sunlight of which heat level equal to 0.7 time of temperature read from Natural Wet Bulb Thermometer plus 0.2 time of temperature read from Globe Thermometer and plus 0.1 time of temperature read from Dry Bulb Thermometer.

4. PRINCIPLES

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5. ROLES AND RESPONSIBILITIES

5.1 Line management or superior level

- To supervise and ensure that health risk assessment guideline has been suitably applied.
- To promote occupational health culture to the employees to make them realize about risks from their working environment and use appropriate carefulness to minimize risk to health which may occur to themselves, the colleagues and the organization.

5.2 Occupational Physician

- To identify, diagnose and provide recommendation on health risk assessment results.
- To specify guidelines and measure to control, supervise and minimize impact from health risk assessment.

5.3 Security, Safety, Occupational Health and Environment Department

- To conduct health risk assessment;
- To supervise and ensure that the departments and the operators have undertaken health risk assessment which is consistent with the laws and the standards;
- To promote, push forward, create awareness including stipulate measures for prevention and reduction of impact from health risk assessment
- To coordinate with the occupational health experts on awareness, understanding and to notify health risk assessment process to the employees in the relevant department for acknowledgement and implementation;
- To monitor, inspect and summarize health risk assessment results within the departments and report the superiors and the relevant persons for acknowledgement.
- To supervise, oversee and operate health promotion program for the sake of employee's healthy;
- To set up database, employee's health report, analysis of illness and disease prevention guideline to increase working efficiency of the employees;
- To provide health knowledge and information;
- To effectively supervise and coordinate on medical emergency service provision with the relevant agencies/hospital.

5.4 Human Resources Department

- To supervise and coordinate with the hospital or the relevant agencies for the employee in case the employee has to be treated in the hospital or other agencies which have been covered by the medical treatment policy to facilitate the employees and increase the employees' satisfaction level.
- To prepare a guideline/procedure manual on medical service operations, so that it can be used as a systemically and efficiently guideline.

5.5 All operators (Employees and Supervised Contractors)

- All operators, including the employees and the supervised contractors are obligated to comply with the occupational health operating procedures and the rules specified by the Company.
- All operators must be trained on occupational health in the workplace, which is regards as a part of the assigned works.
- All operators have duties and responsibility for occupational health works;
- All operators must realize and understand about risks from environmental factors which may impact to health while operating the works.

6. DETAILS OF PROCEDURE

6.1 Process Details

6.1.1 Health Risk Assessment (HRA)

6.1.1.1 Risk assessment is a part of risk management which is widely used in the occupational health works for a long time. It is multiplied by two factors, or matrix, with

objectives to rank health risks and prioritize necessity on hazard control as well as to consider for suitable selection of control measures. Factors considered are Probability on occurrence of undesired incident and Consequences of such incident.

For this health risk assessment, "Probability" means the exposure to health hazards, by considering both intensity of hazard exposed and frequency of exposure. Intensity has been divided into 5 levels, as per percentage of Occupational Exposure Limit (OEL) matrixed with frequency of exposure. While "Consequences" is health effect and criteria for qualitative measurement of health effect is also divided into 5 levels, i.e. no impact, minimal, medium, severe, and very extreme.

Objectives of occupational health risk assessment are to proactively and systematically identify health hazards from working environment, to assess potential or risk which may be harmful to health, and to define suitable control measures to implement as the health protection measures for good livelihood of the employees. Therefore, health risk assessment is the process which comprises of the operating procedures which required to conduct repeatedly and continuously in cycle and it needs cooperation from the Quality, Security, Safety, Occupational Health and Environment Department, Department Managers, Employees and Public Health and Medical Personnel (Occupational Physician, nurse, health personnel in other branches) to blend knowledge, experiences and skill of each person for support for such processes.

Health risk assessment in the workplace divided pursuant to period of time and depth of study into 3 types as follows:

1) Baseline HRA is a comprehensive assessment which covered all kinds of hazards exposed. It is used to identify health risk from the present operations.

2) Issued Based or Targeted HRA is a more detailed assessment of the production process or job or area which has to expose to hazards that the Baseline HRA results are classified in the significant levels, such as severe impact, or very extreme impact.

3) Continuous HRA is a continuous assessment or a scheduled review to consider whether there is a change in condition or working condition, the exposed process, task and area or not. Those changes can change hazard exposure which may impact to a change in risk level or not. Risk management may also include in this continuous HRA.

Health risk assessment from this operation may be regarded as qualitative assessment which assesses exposure by estimation or comparison. It is not a measurement or air samples taking for analysis and it has qualitative risk levels, such as, not significant, low, medium, high, and very extreme. Generally, baseline HRA applied this type of assessment or it may be semi-quantitative risk assessment which assesses exposure by measurement or sampling of air for direct analysis, but it still has qualitative risk levels. Issued based or targeted HRA usually uses this type of assessment.

6.1.1.2 Health Risk Assessment Process

Health risk assessment process comprises of 4 main components

1. Hazard Identification

1) Identify health hazards and health effects from such hazards;
2) Identify risk group (group/person who is exposed to hazards);
3) Identify exposed process, task and area.

2. Hazard Characterization or Dose-Response Relationship
3. Exposure Evaluation
   1) Evaluate, measure or confirm exposure;
   2) Control measures' effectiveness evaluation.
4. Risk Identification
   1) Analyze health effects levels of health hazards exposed by compare with Occupational Exposure Limits (OELs);
   2) Rank risk levels (not significant, low, medium, high, very extreme);
   3) Prioritize for further operations.

All of 3 types of health risk assessment above have 4 similar components. After risk characteristic has been known, further process is health risk management, which is the decision-making process based on risk assessment results by considering alongside with other components, i.e. organization policy, technical possibility, economic possibility including information (obtained) from risk assessment with the purpose of development of potential control measures. After that those control measures will be analyzed and compared where the most suitably control measure will be selected.

Risk Management and Health Risk Assessment Operations

1) Develop, operate and monitor Risk Control Action Plan or review the existing risk control plans;
2) Arrange and retain health risk assessment results correctly and systematically or improve the existing risk control plan and use control measure as the additional alternative or increase the existing measures, as appropriated;
3) Review and improve health risk assessment regularly, such as, every 1 year, 2 years, 3 years or when there is an update or a change in the production process.

During review or improvement process of health risk assessment, it should predict new or potential health risk which may occur or has occurred and register such risks including prioritize them for further operation.

Departments and the persons relevant to health risk assessment as mentioned earlier must assess 3 types of health risks, starting from Baseline HRA first to identify significant level of hazards, risks and areas required to conduct Issued Based or Targeted HRA. Development of exposure assessment strategy and the monitor program to control the Continuous HRA can lead to addition information or findings of new hazards for Baseline HRA. This cycle should continue performing like this. The followings should be considered while undertaking of a new health risk assessment or reviewing the existing health risk assessment:

- All routine and non-routine tasks of new activity or new development project (survey, design, construction);
- All existing operations;
- Activities which have been changed (expansion, change of new production process);

- Project closing or discontinued production (the plant is shut down and the restoration);
- After incident/accident.

Baseline HRA and Issued Based or Targeted HRA are required to perform for new production process, new substance or sample analysis, new activity and working method, beginning from the framework and design processes to set up measures for maximum efficiency on reduction and control of hazards in the working environment. It should be collaboration works among the design engineers, officers from the Quality, Security, Safety, Occupational Health and Environment Department and the work supervisors to identify:

- Matter which might be health hazard;
- Works and activities that the workers may expose to those hazards;
- Probable exposure level;
- Suitable occupational exposure limits (OELs);
- Health trend and basic good quality of life of the worker in the risk group and those information will be used to design for control exposure and to specify operating procedures;

6.1.2 Identifying Health Hazards and Health Effects

6.1.2.1 Hazards in Working Environment

Hazards in working environment may be divided into 4 types, i.e. physical hazard, chemical hazard, biological hazard and ergonomics hazards.

6.1.2.1.1 Physical Hazard. Physical environment condition which may have health effects are as follows:

1) **Lighting** is very important and necessary component in the work. If lighting is not suitable with the working requirement condition, it can make the work convenient or dangerous, such as too much or too little lighting and etc. Measurement unit of light intensity is Lux or foot candle (fc). Generally, lighting come from 2 main sources:
   - Natural light: Mostly natural light is from sunlight;
   - Invented light, i.e. lighting from electricity. It must be chosen correctly pursuant to work characteristics. In case of too little lighting, it may make worker put too much effort for staring/gazing. Iris of eyes are forced to wide open and it will lead to eye muscle fatigues, eye pain, dizziness or headache. Hence, it may make erroneous work that it can lead to accident in the workplace. However, if a place has too much lighting or exceeds the user's requirement, it may make eye fatigue, eye pain or conjunctivitis, cornea inflammatory and tissue at retina, which can deteriorate eyesight or even blind.
2) **Noise**. Loud noise is the physical hazard which is found in the workplace or industrial factory. Loud noise impacts to health, both physically and mentally and it may impact to work efficiency. Health impact that the Quality, Security, Safety, Occupational Health and Environment Department places importance is the hearing loss and loud noise from 80 Decibel A can lead to such impact.

3) **Heat**. Human body can function and live the life normally when core temperature is steady or slightly fluctuation (37± 1 degree Celsius). Heat can have psychological effects, i.e. easily moody, fatigue, restless, distracting and it can lead to systematic effects, such as heat cramp, heat exhaustion, heat stroke. Material heat source in the workplace and industrial factory may be from furnace, oven, machine or may be from sunlight while working outdoor for recording values or collecting samples. However, heat may not be a problem or harmful to the employees who work in the laboratory where temperature has been constantly controlled.

4) **Cold**. Working in area which has lower temperature than normal, such as in the cold storage industry or work where very low temperature is required in the production, may make the workers numbness, unconsciousness due to bad blood circulation or blood stop circulating for a long time and it makes septic infarct. Normal diseases from cold are Chilblains, Frostbites or Raynaud's Phenomenon.

5) **Radiation**. Radiation is divided into 2 types as per energy level which is associated with length of such radiation waves, i.e. Ionizing Radiation and Non-Ionizing Radiation. For instance, ionizing radiation found in the factory is Gamma Radiation which is used in measurement of substance level in tank and inspection of connecting joint of pipe. Known hazard for Ionizing Radiation is cancer. Non-Ionizing Radiation is UV radiation or ultraviolet radiation and infrared radiation. Radiation that people who work outdoor and expose to sunlight for a long time, for instance, while inspection of production process of the factory, is UV radiation from sunlight which may cause skin cancer.

6) **Vibration**. Normally, vibration which is relevant to work is vibration from tool, machine, engine and vehicle. Therefore, the work performer has an opportunity to expose to whole body vibration (WBV) or Hand-Arm Vibration (HAV). Impact from whole body vibration (WBV) is back pain while impact from hand-arm vibration (HAV) may lead to Raynaud's Phenomenon or Raynaud's syndrome.

7) **Abnormal Pressure**. is pressure which is higher or lower than atmospheric pressure at sea level or standard pressure (ATM) which equal to 760 mmHg. It can be classified into 2 characteristics as follows:

   - Abnormal low atmospheric pressure. People who work in a very high place, such as airline cabin crew or people who travel by plane will have aeroembolism and it will expand in body tissues, which may cause oxygen deficiency which may lead to fatigue, sleepy, headache, vomiting. If this gas bubble is at muscle and joints, it will cause cramp, ataxia and may cause paralysis if gas bubble clogged at vessel to brain.
   - Abnormal high atmospheric pressure. Working in environmental condition which has higher pressure than standard atmosphere (ATM), such as working in underground tunnel, working underwater or under deep sea that pressure from outside and inside body is differently, so it make body has compression and it may lead to ear pain or ruptured eardrum. The deeper will cause the higher compression, so pain will increase and it may be life threatening. In addition, it may cause drowsiness because nitrogen dissolves in the brain. When leaving high pressure condition to normal

pressure condition, it will cause nitrogen bubble, which may cause pains in joints, muscles or it may cause stroke/paralysis.

6.1.2.1.2 Chemical Hazard. Chemical is regarded as health hazard. Risks from chemicals in working environment are caused by consuming of chemicals into the body via nose, mouth and/or skin. However, during operation, important channel that chemicals can enter into the body is nose by inhaling, while entering via skin may be occur from time to time, for instance, in case chemicals accidentally spilled into hands while preparing chemicals or sampling without wearing gloves or usage deteriorating gloves or gloves which are not suitable with type of chemicals. Therefore, health risk depends on intensity of chemicals in the air of the working environment and period of time exposed to chemicals. Chemicals which are solid (suspended solid particle in the air), liquid (both solution and suspended particulate matter in the air), gas or vapor which may cause one or more impacts to health as follows:

1) **Irritation:** Irritation caused by inflammation of tissue which exposed to substance. Normally, structure of tissue which has not been damaged will be recovered when exposure is ceased. So it has low severity impact, if it does not have subsequent symptom or other severe impact. Tissue which may have irritation is skin, eyes and mucous membranes.
2) **Asphyxiation:** Asphyxiation occurs when cells are lack of oxygen, which is essential for building up energy. Substance which makes cells or body lack of oxygen (asphyxiation) can be divided into 2 types as follows:
   - **Simple Asphyxiants** are gases, such as hydrogen, methane, inert gas and carbon dioxide, which do not have chemical reaction in the body but they can obstruct oxygen into cells. If those gases become so concentrated, they displace oxygen in the ambient atmosphere, thus cause oxygen deprivation in those who are exposed.
   - **Chemical Asphyxiants**. This substance will have chemical reaction in the body which prevents the delivery of oxygen from the bloodstream to cells, even in the presence of adequate oxygen levels in the blood. Chemical asphyxiants include agents such as carbon monoxide which has an affinity for haemoglobin that is around 300 times greater than that of oxygen; hydrogen cyanide which inhibits oxygen exchange at cell level by having affinity with enzyme that control oxidation of cell; and hydrogen sulfide which has inhibition process for oxygen intake of cell, similar to hydrogen cyanide.
3) **Narcotics and anesthetics**. Chemicals which cause narcotics and anesthetics will have reaction with body and compress central nerve system which causes headache, dizziness, nausea, unconsciousness and death if chemical has been entered into body in a very large amount and in the short time. Severe of symptoms associate with amount of substances intake into the body and endurance of each person. Samples of those chemicals are acetylene, ethylene, chloroform, ether, chemicals in aliphatic ketone group and chemicals in aliphatic alcohol group.

4) **Lung Fibrosis**. Some particles have qualifications which can cause lung fibrosis, such as silica, asbestos, dust, coal dust. These particles will not disintegrate or they take a very long time for integration or removal out of lung. They can make lung irritation, so the body builds tissues to cover such particles which make lung thicken and become fibrosis, lack of elasticity, so lung can lessen expansion and contraction. It also lessens oxygen exchange, which make the patents get tired easily and their heart has to work harder. At present, this disease cannot be completely cured, so the patient has to adjust his/her lifestyle, for instance, refrain from activities which require exertion in order to be able to live with this disease.
5) **Cancer** is very difficult to cure and treatment cost is very high but it can be completely cured if it can be found during the initial stage. Chemical in the industry which has been confirmed as carcinogen is benzene which can cause leucosis, and vinyl chloride which can cause brain cancer.
6) **Reproductive Effects**. These effects may occur to female or male and it can cause abnormality in reproductive organ, sexual behavior, sterilization, low amount or abnormal sperm, atresia folliculi, abortion. Substances which may have such health effects impact is carbon disulfide, as it can lead to sexual dysfunction, abnormal shapes of sperm and low amount of sperm, and solution in laboratory, such as benzene, toluene, ether, can lead to abnormal menstruation and abortion.
7) **Teratogenicity** caused by chemicals which make growth of tissue cells and development of fetus abnormally. Consequently, it interrupts the growth of organs which are developing during the crisis period, that is, the first 8-10 weeks of pregnancy. Samples of those substances are ethylene dibromide and Poly Chlorinated Biphenyls (PCBs).
8) **Mutagenicity**. Substance which can change gene in chromosome nucleus of cell, so abnormal chromosome has been transferred to the younger/next generation and cause abnormality. It is difficult to study and follow-up because it takes longer time before impact of abnormality occurs. However, well-known substance which can cause this impact is radioactivity.
9) **Systemic Effects**. Substances which enter into the body by either means, accumulate in organs or either part of the body usually impacts to one or more than one target organs and usually impacts to functional system of overall body. System which usually has been impacted is central nervous system. For instance, when lead gets into the body, it accumulates at the bone but it can cause impact to erythropoiesis, nervous system, reproductive system which can result to functions of other systems in the body. Mercury which has 3 formats, i.e. metallic mercury, organic mercury and inorganic mercury, and all 3 formats impact to various systems of the body, such as central nervous system and kidney.

Apart from health effects as per abovementioned earlier, chemical hazards on incubation period of disease or illness should also be considered for risk assessment and health surveillance. Health effects can be divided into incubation period as follows:

1) **Acute Health Effects**: Effect which show symptom within 24 hours after exposure, usually after Acute Large Dose Exposure, for instance, in the event of accidentally leakage of volatile organic compounds (VOCs), person who is exposed to substance which has high concentration will have eye irritation, headache, nausea, vomiting immediately or within a few minutes or hours after exposure.
2) **Chronic Health Effects** are effects occurred after long exposure, i.e. months or years, and it usually occurs after repeated exposure for many days, weeks or months (Acute Large Dose Exposure). This exposure period may impact to severity of disease or symptoms or risks, for instance, if exposure of n-Hexane by inhaling or through skin for a long time, it may cause abnormal nerve at legs or hand, which can lead to numbness at fingers and toes.
3) **Long Latency Health Effects** are effects which takes time for development of disease after exposure has ended, such as malignant mesothelioma and peritoneal mesothelioma caused by mesothelioma; lung cancer and lung fibrosis, i.e. Silicosis, Asbestosis which may occur after stop exposing for more than ten years.

One of the points that should be well aware concerning chemical hazard is chemical interaction because there is probability to be exposed to more than one substance while working and such substances may have interaction. Consideration criteria is that if substance effects to the same system or organ and there is no information that showed that those substances have independent effect, antagonistic effect or synergistic effect, it should be regarded that such substances have Additive Effect, such as BTEX which is the mixture of benzene, toluene, ethylbenzene, and xylenes. All 4 substances have effects to central nervous system. Calculation of concentration of mixture substances is as follows:

$$\frac{C_1}{T_1}+\frac{C_2}{T_2}+--+\frac{C_n}{T_n}$$

If result exceeds 1, it means that concentration of mixture substance exceeds OLEs, but if it is lesser or equivalent to 1, it means that concentration of mixture substances is lower than or equal to OELs of such mixture. Where C_n is concentration of substance in the air no. n and T_n is OLEs of n substance, and n means sequential number from 1,2,3.... to n.

6.1.2.1.3 Biological hazard which has found in the working environment is divided into 5 groups:

1) Microbe-organism and toxin from microbe-organism;
2) Unicellular plant, such as mushroom, fungus, fern;
3) Multi-cellular plant which has toxin or allergic substance, such as cowage, when directly expose to such plant.
4) Invertebrate such as spider, ant, bee, other poisonous insects, parasite, worm and etc.
5) Protein from poisonous vertebrates, such as urine, feces, saliva and dander.

Of all 5 biological hazard groups, Group 1 and Group 2 might be found in the working environment, for instance, microbe-organism may be contaminated in soil sampling in the laboratory, and it might find Legionella Bacteria, which can cause Legionnaire Disease, a respiratory syndrome, in the cooling tower. In addition, both the operators' rooms and the offices may have problem about Indoor Air Quality (IOQ) if their environmental conditions are suitable for the growth of fungus and bacteria which are everywhere in the air.

6.1.2.1.4 Ergonomics. Ergonomic hazards, such as improper working conditions, such as lighting, noise, temperature, vibration, machineries speed, repetitive works, size of equipment and machines (which are not suitable with size and proportion of the operator) and work characteristics in unnatural postures, such as works which are required to bend bodies, bowing, contortion, reach out or lift materials above the head repeatedly or for a long time. It seems that working in the control room has more ergonomic problems than other works, because it requires staring at the monitor all the time, so the employees should change their posture or exercise to reduce ergonomics problem among these employees' group.

Body of knowledge on hazards in the working environment as mentioned above plus information of the working environment, production process, work procedures, relevant chemicals

information/report, disease/injury statistics, number of workers and etc., can lead to hazard identification, which is the 1st component of Health Risk Assessment.

6.1.2.2 Identifying Health Hazards

Identifying health hazards comprise of 3 components as follows:

1) Identify health hazards which should be operated together with Hazard Characterization or Dose-Response Relationship which is the 2nd component;
2) Identify risk group (group/person who is exposed to hazards);
3) Identify exposed process, task and area.

Such identification requires having knowledge on production process, relevant chemicals, production layout plant, number of employees in each section/department, nature of work and etc.

Even though outstanding hazards of activities in each production process or each task of the Employee may be different but all hazards are classified into 4 types as per abovementioned and they have similar hazard identification processes, for instance, it must start from study of production process, working procedures, relevant chemicals, job characteristics, statistics of diseases/injuries/accidents from work and etc. of the section or department which needed to undergo health risk assessment.

6.1.2.2.1 Production process and job characteristics. Health hazard identification should commence from acknowledgement of production processes and all job characteristics of the plant, from raw materials to be used in the processes, all chemicals used in each process until the products to be submitted to the

customers. Hence, information of main chemicals used and health impact from those chemicals will be known.

6.1.2.2.2 Hazard identification process. After understanding the overview of works of the departments which need to have health risk assessment, hazards can be identified pursuant to the following processes:

1st Process: Study and analysis from the available document and information (Desk-Top Analysis). This method of hazard identification will be useful only when there are previous risk assessment results and records of other work employment, including various reports, such as incident reports, audit reports, occupational illness and injury reports, maintenance reports and abnormal work of machines/tools, health surveillance record, sick leave report, previous industrial hygiene measurement results, area inspection report, safety committee's minutes and the most important information is safety data sheet (SDS).

2nd Process: Walk Through Survey is the survey of areas and operating areas to collect information of working environment which may be harmful to health, exposure frequency, such as once a month, once a week, every day or every hour. Exposure characteristics, such as inhalation, skin, oral, ingestion and learning about basic information of the workers which including health condition, both physically and mentally, by using 5 senses, as well as from observation and making enquiry.

During walk through survey, the operators should be interviewed in order to gather details of work pursuant to duties and responsibilities of each work position and verify correctness against the information obtained from the 1st process.

3rd Process: Hazard Rating which means tendency or probability to have health effects upon exposure to such hazard by specifying as numbers from 1, 2, ... to 5. Level 1 – means it does not have any impact and impact begins to be more severely until at level 5 which is extreme severe (Table 1). Necessary information for hazard rating is SDS, health effects of chemicals, dose-response relationship and health effects of substance

Table 1: Hazard Rating

Level	Severity	Health Effects
1	No	It does not have any health effect*.
2	Minimal	It has minimal health effect, but medical treatment is not needed. Symptom is not severe that sick leave is required. It does not impact to work operation or it is not a cause for disability. It can be recovered without medical treatment.
3	Medium	It has severe health effect but it can be recovered with the medical treatment. It may lead to absence of work or sick leave or it may have accumulated impact from repeated or prolonged exposure. It is not life-threatening.
4	Severe	It has permanent health effect, severe injury and it cannot be cured. The patient must adapt him/herself to live with such illness or impact.
5	Very Extreme	It can lead to dead or disability or illness that can make the patient becomes a helpless person.

Source: Applied from Notification of Ministry of Industry, No. 4439 (B.E 2555 – 2012)

Note: * At present, no information which can indicate that it has health effect.

6.1.2.3 Identifying Exposed Workers

The objective of identifying exposed workers is to set up the exposure evaluation and control. If it is found that health risk is in unacceptable level, particularly, when there are a lot employees and individual risk evaluation might cost a lot of expenses. Therefore, Similar Exposed Groups (SEGs) have been organized, after that the employees in each group will be random to evaluate exposure and risks. Exposure evaluation results will be for the employees of the whole group. This risk evaluation method is effectively and efficiently. Normally, the Similar Exposed Groups can be organized by using 2 methods as follows:

1st Method: This method involves analysis of information gathered from identifying health hazards and from identifying exposed process, task and area. There are various guidelines for classifying SEGs and each department may require more than one guideline to ensure that SEGs has been appropriately organized, as follows:

1) Consider from the exposed process and chemicals in the working environment, in the organization/plant of which the processes have been clearly divided into departments and the operators in the department have similar exposure and similar frequency. The operators in such department may be in the same SEGs, such as employees in the laboratory, control rooms in the plant and etc.

2) Consider from the exposed process, assigned duties or tasks and chemicals in the working environment. The operators who are in different job position or duties, even though they are in the same department or in the same working environment, may be exposed differently. Hence, if the operators who are in the same department/laboratory and expose to similar substance in the working environment, the assigned duties or tasks or job position of each person should also be considered, for example, if the jobs have to be performed in the same laboratory, but the 1st person is responsible for assessment of absorbent, but the 2nd person is responsible for analysis work, so substance exposure is differently. Consequently, it should not organize the employee whose work is to assess efficiency of absorbent and the employee whose work is the analysis into the same group.

3) Consider from the exposed process, assigned duties or tasks, jobs performed and chemicals in the working environment. The operators who work in the same laboratory and in the same duty but the works performed are differently, so they may be in different SEGs. For instance, the employees who work in the same chemical laboratory, where the 1st person tests at room temperature, but the 2nd person tests by increasing temperature. Hence, even though they are exposed to the same substance but the exposure level may be differently, so they might be in different SEGs.

4) Consider from the same team work. The employees in the same team may expose to substances similarly or differently, so classification of SEGs should also be considered from the works performed. For example, there are 3 persons in the engine pollution test

team: one officer and two technicians. If 3 persons perform duties differently, the one whose duty is to exchange fuel may be higher exposed than others, that he/she cannot be classified in the same group of other persons in the same team.

5) Consider from nonrepetitive works (nonroutine operation). Substances exposed by some departments/sections may constantly change. For example, the laboratory may analyze chemical samples with different methods each time; the job may be assigned to the operator from time to time and each time is differently from each other. For this case, the objective for classification of SEGs should be mainly considered. For instance, if it is considered based on legal compliance, the worst case scenario should be considered, but if the objective is for surveillance, each period or each job should be considered.

2nd Method: Classification of SEGs by collecting air samples for chemical exposure evaluation. Consideration criteria is that if average exposure of 95% of people in the group throughout the working period is not different more than 2 times of average values, it will be considered that those people are in the same SEGs. However, average exposure of the group should also be considered. If average exposure of the group is high, such as 0.5 to 1 time of OLEs, it means that some of the operators in the group may expose to substance higher than OLEs. Therefore, new group should be organized to reduce such differences. Persons who expose to substance during 0.5 to 1.0 times of OLEs should not be in the same SEGs because exposure control measures of those 2 groups should be differently.

6.1.2.4 Identifying Exposed Process, Task and Area

Walk through survey of process can help in identifying exposed process, task and area and the followings should be reviewed and considered for systematically and completely operation:

- Points to consider for process and task are permanent job, non-permanent job, emergency situation, working hours, shift rotation and the existing control measures.
- Points to consider for tools and machines are design and working condition, application method and training on how to use it; it can be used or not; there is constant maintenance in place or not; it is installed in area which is associated with other activities or not. Other consideration points are hazard occurred from those machines/tools, such as dust, heat, vibration, radiation or pollution emission.
- Points to consider for environment and location are adequate ventilation, suitable control of temperature and humidity, ergonomics design of the workplace, lighting, adequate surrounding areas.
- Record and tendency of physical examination result for health surveillance to observe abnormality which may appear for each exposed task, process, and area.

Normally, task or activity, process and area which are deemed to be evaluated are:

- Hazard exposure has tendency to be higher than OLE-TWA.
- It has severity that it can lead to accident or there is a claim or complaint from the operators in such area.

- New task, process and area of which health risk assessment has never been performed before.
- It is required by the laws.

For the 2nd component: Information related to health effects or dose-response relationship is important information for health risk evaluation to be used for ranking hazard levels (Hazard Rating). Such information can be obtained from literature review or retrieval from epidemiological information and/or toxicology of chemicals, such as academic article, injury report of the chemical-exposed employees, health effects from exposure of different volume of substance, physiological responses and supporting document on determination of OELs and SDS. SDS is a source which can be easily accessed because the law has specified that all establishments must have SDS, so that the workers can use for safe operation. Apart from the abovementioned document, article and literature, there are websites which have useful information for occupational health works, such as, www.osha.gov, www.cdc.gov/niosh, www.epa.gov, www.hse.gov.uk, and etc.

6.1.3 Exposure Evaluation

6.1.3.1 Exposure evaluation is an estimation of amount of substance exposed by the body and exposure rating because substance can enter into the body via 3 means, from oral ingestion, nose (inhalation) and skin. Presently, the operators' hygiene is better because there are rules or practices that prohibit eating in the workplace which has hazardous substance. Hence, the opportunity that chemicals can enter to the body via oral ingestion is very unlikely during normal working condition, so nose (inhalation) and skin are important means that chemical can enter into the operators' body (if operator directly exposes to substance and such substance can penetrate into the skin). Therefore, the Quality, Security, Safety, Occupational Health and Environment Department has to conduct exposure evaluation by taking air samplings for analysis (Environmental Monitoring) together with the Biological Monitoring, if such substance can and has opportunity to permeate via the skin.

As air samples taking method has been conducted for analysis, at both individual person and at ambient air in the working environment, therefore, if there is control measure at sources (engineering control) in place, it can be regarded that air samplings can also be used for efficiency evaluation of control measures. However, if the control of substance exposure is used by wearing personal protective equipment and by compliance with the procedures specified, such air samplings cannot be used for efficiency evaluation of control measures because the efficiency of this measure does not only depend on the correct selection and usage, it also depends on the operator whether he/she can use/comply with or not. Hence, for exposure evaluation, efficiency of control measures must be evaluated so it can reflect exposure level and for benefits on risk management.

6.1.3.2 Estimation of Exposure Level

Objective of estimation of exposure level is to explain characteristics of exposure, which consists of intensity of substance in the air and exposure duration of each

SEGs, each exposed task, process and area. Therefore, for estimation of exposure level, hazards that the groups of employees have similarly exposure including the exposed process, task and area should be taken into consideration by reviewing document, walk through survey and having conversation with the managers and the employees. In addition, estimation of exposure level may be "qualitative exposure" or "quantitative exposure".

6.1.3.2.1 Estimation of qualitative exposure. Normally it is used with preliminary risk assessment where each employee must record information about his/her own hazard exposure, by using occupational hazard exposure record form (HES-F-0002) and form for recording and screening for SEGs classification in each department (HES-F-0003) to estimate hazard level exposed and identify hazard from such information. Moreover, exposure can be estimated from walk through survey to identify health hazards or from previous measurement results or from comparison of tasks in similar characteristics or use all methods mentioned above together if information is available. Some of the examples are:

- Estimation of intensity level of mercury exposed by the employees/operators in the plant may be considered from air samples taking and from analysis in areas where the employees work. For instance, mercury in mercury treatment unit area is 0.0021 mg/m^3, which has maximum value when comparing with other mercury treatment units. Hence, if there is no other task or area apart from mercury treatment unit and log sheet work, estimation of intensity level of mercury exposed by the employees should be lower than 0.0021 mg/m^3 because the employees work in such area for approximately 1 hour per day.
- Intensity level of mercury exposed by the employees in the laboratory for testing of efficiency of mercury absorbent may be estimated from air sampling taking in the water laboratory of the plant, etc.

In addition, in order to make estimation of exposure level more precisely, the following matters should be studied/considered:

- Nature of exposure, whether it is high or low, close to each other at all times or it is in high level periodically or equally throughout the continued exposure or periodically;
- Which process or task can increase exposure?
- Have conversation with the employees in order to understand about their concept, knowledge and experiences relating to work, related hazard and the existing control measures;
- Study about non-routine tasks and activities which are performed from time to time, such as maintenance work, loading/unloading of substance/goods and a change of production cycle.
- Consider about the task which has not been planned in advance but it can be predictable, such as failure of machine and equipment, production halt or interruption which may cause an accidentally exposure to substance.
- Workers who are not directly relevant to such task or activity but they perform the work in nearby areas that they may (have opportunity to) expose to hazard.

6.1.3.2.2 Estimation of quantitative exposure. This work can be performed by suitably measurement or taking air/biological samples as per specified by the industrial hygienist or the responsible person in the sampling strategy plan. All types of samplings taken or analyzed must be performed by the method which has accuracy, reliable with suitable quality control method and it should be performed when:

- It is suspicious that hazard exposed exceeds the specified standards of Occupational Exposure Limit (OEL) or not;
- Excessive exposure of substance might have severe health effects;
- It is required to have information to make decision on control measures;
- Selection of control measures will depend on exposure level;
- It is required to evaluate efficiency of control measures;
- Need to create awareness in the worker groups;
- It is the legal requirements;
- It is an investigation or a response, when there is an injury report or there are health effects.

In addition, collection, sampling analysis and measurement method which are acceptable and widely used can be found from the following websites:

- http://www.cdc.gov/niosh/docs/2003-154/
- http://www.osha.gov/dts/sltc/methods/
- http://www.hse.gov.uk/pubns/mdhs/

Source on how to collect and analyze biological sampling can be found from a book, ACGIH®'s TLVs® & BEIs®.

6.1.3.3 Exposure Rating

Exposure rating depends on intensity level of substance or heat level or noise level, and it will be considered jointly with exposure duration. Therefore, it should consider criteria specified in Table 2: Intensity Level; Table 3: Heat Level; Table 4: Noise Level, Table 5: Radiation Level, which divided into 1, 3 and 5 levels and they must associate with Occupational Exposure Limits (OELs). Table 6: Exposure Frequency will reflect hazard exposure duration, by dividing into 5 levels. Matrix of Table 2, 3, 4 and 5 with Table 6 which is displayed in left side of Table 7 and compares the results which is exposure level from the right hand side of the same table.

Table 2: Chemical Level

Intensity Level	Average Intensity Level Exposed by the Workers**
1	< 10% of OEL-TWA
2	< 50% of OEL-TWA
3	< 75% of OEL-TWA
4	75 - 100% of OEL-TWA
5	> 100 % of OEL-TWA

Source: Applied from Notification of Ministry of Industry, No. 4439 (B.E. 2555) **Remark****: Consider from exposure, without taking into consideration the wearing of respiratory protection device.

Table 3: Heat Level*** **(It must use jointly with Table 3.1)**

Heat Level	Heat Level exposed by the Workers (°C)
1	WBGT □ OELs – 7.5 °C
3	OELs – 5 °C □ WBGT < OELs – 2.5 °C
5	□ OELs

***Source**: Applied from Code of practice for Health Risk Assessment by the health risk assessment taskforce, the Petroleum Institute of Thailand*

***Remark**: *** Heat level exposed has only 3 levels.*

Table 3.1: Temperature Limit of Each Job Characteristic

Job Characteristics	Temperature Limit (OELs)
Light Work	34 °C
Medium Work	32 °C
Heavy Work	30 °C

***Source**: Applied from Ministerial Regulation on the Prescribing of Standard for Administration and Management on Occupational Safety, Health and Environment in relation to Heat, Light and Noise B.E. 2549 (2006)*

Table 4: Noise Level

Noise Level	8 Hour Time Weighted Average (Decibel A)
1	< 73.4
2	< 85
3	< 87.9
4	87.9 - 90
5	> 90

***Source**: Applied from Ministerial Regulation on the Prescribing of Standard for Administration and Management on Occupational Safety, Health and Environment in relation to Heat, Light and Noise B.E. 2549 (2006)*

Table 5: ****Ionizing Radiation Level

Radiation Level	Surveillance Radiation Level (micro Sievert per hour; µSv/hr)
5	7.5

***Source**: Applied from Evolution of ICRP Recommendations 1977, 1990 and 2007*

Remark**: * Radiation exposed level has only 1 level.*

Table 6: Frequency Exposure Level

Frequency Level	Frequency	Exposure
1	Rarely	1 Time per Year or □ 8 hours/year
2	Infrequency	2 to 3 Times per Year or > 8 – 24 hours/year
3	Often	2 to 3 Times per Month or > 24-288 hours/year
4	Very Often	2 to 4 hours continually per shift or > 288 – 1000 hours/year
5	Regularly	Continually exposed throughout the shift or > 1000 hours/year

***Source**: Applied from Notification of Ministry of Industry, No. 4439 (B.E. 2555)*

***Remark**: Shift means working continually for 8 hours or longer but not exceeding 12 hours*

1 year means 2,000 hours or 250 days

1 day means 8 hours

1 time means 1 day

Table 7: Exposure Level

Intensity Level: Heat Level / Noise Level / Radiation Level — Frequency Level	1	2	3	4	5	Exposure Level		
						Score	Result	Level
1	1	2	3	4	5	1 to 5	Not significant	(1)
2	2	4	6	8	10	6 to 8	Low	(2)
3	3	6	9	12	15	9 to 15	Medium	(3)
4	4	8	12	16	20	16 to 20	High	(4)
5	5	10	15	20	25	21 to 25	Very High	(5)

***Source**: Applied from Notification of Ministry of Industry, No. 4439 (B.E. 2555)*

Example 1: Evaluation of mercury exposed by the employees who tested efficiency of mercury adsorbent and who analyzed mercury in adsorbent (it is specified that this employee/this group exposed to mercury from two tasks only). Based on information on air sampling in the laboratory, it was found that intensity of mercury in the air is lower than value which can be detected and when study by comparing with information of the water laboratory of the plant which has similar job characteristic and involved mercury also has small amount, it was found that intensity of mercury in the air is 0.0048 mg/m^3, so this intensity level has been used for evaluation and comparison with OELs which is = 0.25 mg/m3.

Intensity rating = 2 (exceed 10% OELs but not exceed 50% OELs). The employee conducted efficient test 3 hours a day, 5 days/week and analyzed mercury in adsorbent approximately 30 minutes a day, one day/week. Consequently, total time the employee may expose to mercury is 15 hours 30 minutes. When comparing with criteria in Table 6, the result is:

Frequency exposure level = 4 "Very Often"

Matrix of intensity level and frequency level = 8, when compared with criteria in Table 7, right hand side

Exposure level = (2) "Low"

6.1.3.4 Control Measures' Effectiveness Evaluation

Control measures are the operations and practices which may use tool, technique, process, operating procedures and knowledge provision to eliminate or reduce hazard exposure. Effectiveness evaluation of control measures can be performed directly by measurement of exposure with and without control measure or indirectly by usage available information, such as previous result from air samples and analysis, walk through survey and health records, as well as considering from the following questions and issues:

- What standard is used for selection of level and characteristics of control measures, such as standard on specifying qualification of personal protective equipment (PPE), standard of laboratory chemical fume hood and etc.
- Is there any control measure for the highly exposed process, tasks and area or not and such control measure has been appropriated installed, used and maintained of not;
- Is there still high level exposure even though effective control measures have been applied or not;
- Are function and usage of control measures different from function and usage explained in the guideline and requirement of work procedures or not;
- Does existing maintenance program cover control measures, such as fume hood in the laboratory or not;
- Has control measure been regularly evaluated or not.

The existing control measures can reduce exposure level. Generally, direct evaluation of exposure by collecting air samples or from measurement will be performed while the control measures have also been applied, for instance, turn on fume hood while mixing chemicals. However, usage of personal protective equipment (PPE) and the operating procedures which are the control measure will not be considered because efficiency of PPE, such as face mask and compliance with the operating procedures mainly depends on the usage/operation of the employee. If the employee did not wear or incorrectly wore or did not comply with the procedures, exposure cannot be reduced. Therefore, for samples collection or measurement, it will not consider whether the employee wear PPE or not in order to avoid lower evaluation than actual situation and for maximum protection of the operators.

Nonetheless, for health risk assessment, efficiency of all control measures have to be evaluated, even though the results will not be used for directly calculation of health risk assessment, in order to consider for adequacy of the existing control measures and to further specify alternatives for risk management.

6.1.4 Risk Identification and Risk Management

Risk identification consists of analysis to acknowledge health risk level, by using Risk Assessment Matrix and risk rating, to specify order to priority for risk management.

6.1.4.1 Risk Identification

Matrix result from evaluation of exposure level from Table 7 (right hand side) with severity level of health effects which may incur from hazard exposure (Hazard Rating) from

Table 1, as shown in Table 8 (left hand side). Compare result with risk level, which is dividing into 5 levels, as shown in Table 8 (right hand side)

Table 8: Risk Level

Exposure level / Severity level	(1)	(2)	(3)	(4)	(5)	Risk Level		
						Score	Result	Level
1	1	2	3	4	5	1 to 5	Not Significant	0
2	2	4	6	8	10	6 to 8	Low	1
3	3	6	9	12	15	9 to 15	Medium	2
4	4	8	12	16	20	16 to 20	High	3
5	5	10	15	20	25	21 to 25	Very Extreme	4

***Source**: Applied from Notification of Ministry of Industry, No. 4439 (B.E. 2555)*

Example 2: Characteristics of health risk of employees who exposed to mercury from Example 1.

Exposure level equals to (2) and health effects from exposure to mercury are nervous system, peripheral nervous system, behavioral change, pneumonia, kidney failure, change of color of cornea and eye lens, winking spasm and may cause mutation. However, purpose of the specified OELs is for protect most of the operators from impact to central nervous system and kidney. Hence, mercury at intensity lower than 50% OEL has opportunity or tendency to cause low impact.

Consider to select severity of health effects from Table 1 which is in Level 2 "Minimal" which means that it has minimal health effect, but medical treatment is not needed. Symptom is not severe that sick leave is required. It does not impact to work operation or it is not a cause for disability. It can be recovered without medical treatment.

Matrix exposure level with severity level of health effects [(2) x 2], score obtained is 4 and risk level is 0 "Not significant".

6.1.4.2 Risk Management

Result from risk rating will lead to risk management, that is, hazard which has higher risk level will be prioritized for management plan. There are many guidelines to consider for operation and criteria or consideration guidelines of risk control measures are as per shown in Table 9 and Health Risk Surveillance Measures in Table 10.

Table 9: Risk Control Measures

Risk Level	Score	Risk Control Measures
0 (Not significant)	1 to 5	No additional control measure is required

Risk Level	Score	Risk Control Measures
1 (Low)	6 to 8	It must have risk control measure and environmental surveillance measures
2 (Medium)	9 to 15	Control measure must be put in place as soon as possible
3 (High)	16 to 20	Control measures, i.e. engineering control, administrative control, usage of personal protective equipment must be undertaken immediately. In addition, plan must be prepared for permanent control measures.
4 (Very Extreme)	21 to 25	All operations must be stopped immediately

***Source**: Applied from Notification of Ministry of Industry, No. 4439 (B.E. 2555)*

Table 10: Health Risk Surveillance Measures

Risk Level	Score	Health Risk Surveillance Measures
0 (Not Significant)	1 to 5	No health check-up is required
1 (Low)	6 to 8	General health check-up by the Physician (Medical Examination) at least 1 time a year
2 (Medium)	9 to 15	Health check-up pursuant to risk, at least 1 time a year
3 (High)	16 to 20	Health check-up pursuant to risk, at least 6 months a year
4 (Very Extreme)	21 to 25	Examination, when necessary, such as before and after exposure of a very high risk level

6.1.4.2.1 Surveillance is divided into 2 categories:

6.1.4.2.1.1 Health surveillance

Format for health surveillance is divided into 4 types, as follows:

1) **Review history and medical record relevant to health and previous work experience or questionnaire concerning health and previous work experiences** in order to be used as supporting information for consideration of health examination result.
2) **Medical Examination,** such as look, palpate, tab, listen, system health check-up, history taking and enquiry of symptom by the Physician to evaluate abnormality of the body;
3) **Biological Monitoring**. This is health check-up pursuant to risk with objectives to evaluate whether the body has been exposed to health hazard, such as amount of chemicals, or not, or is it impact to body in the initial stage or not. Biological monitoring can be divided pursuant to examination objectives into 2 types as follows:
   - Biological Exposure Monitoring. It is the evaluation of chemical exposure by analysis for chemicals or derivatives in biological samples, such as blood, urine or halitus. Results will be used to evaluate the amount of chemicals exposed by the employee. Sample of biological exposure monitoring is evaluation of intensity of blood mercury level.

- Biological Effects Monitoring. It can be done by analyze enzyme or cells from biological samples of the employee to evaluate changes of body during the initial stage which is a warning sign. Example of biological effects monitoring is evaluation of impact from hemoglobin synthesis of the body among the persons who worked with mercury, by evaluation from amount of Zinc Protoporphyrin and Delta-Aminolevulinic Acid in blood.

4) Medical Test. It is health check-up pursuant to risk by using medical apparatus for testing, such as Pulmonary Function Testing (PFT), audiogram, occupation vision test, chest X-Ray and blood inspection to check efficiency of kidney, liver and blood counting.

Health Check-up pursuant to risk consists of strategy and method for inspection and evaluation of negative impact to health of the operator systematically. Objectives are to evaluate results of the control measures, inspection for impact from initial stage and for protection of the operators' health. Information gained may be used to search for hazards and risk assessment.

Therefore, health surveillance should be monitored and it should have medical surveillance or health check-up pursuant to risk systemically for the employees who exposed to chemical hazards to prevent them from occupational diseases. In addition, training courses should be arranged to provide knowledge of occupational hazard, health effects in the initial stage which may be detected and referral of the employees for further analysis and treatment. If it is found that there is occupational illness, the existing preliminary control measures should be evaluated, such as environmental monitoring, engineering control, administrative control, and personal protective equipment (PPE). Medical surveillance is supplementary measure (it will not replace preliminary exposure control measure) to search for and control health effects from occupation. Physical check-up should be performed when:

- In case of new employee, before the employee begins to work with hazardous chemical, health check-up should be undertaken to collect basic/baseline health information including history taking on environment and work completely including physical examination, and laboratory inspection which conform to hazard that the employee is expected to be exposed.
- In case of change of work/work transfer, because the employee may expose to other risks, apart from the previous work that the employee might have been exposed to.
- In case of absence for more than 3 days due to occupational injury or illness.
- In case of annual medical examination which is the examination during employment.
- In case of retirement of being employee.

6.1.4.2.1.2 Environmental Surveillance

1) Measurement and analysis of intensity of hazardous chemical in working environment and hazardous chemical storage facility in order to evaluate the employees' exposure in working environment. At present, it has to be performed in order to comply with the Notification of the Ministry of Interior Re: Safety Working in relation to Chemicals, B.E.

2534, which specified that the measurement and analysis of measurement results must not be later than 6 months per each time. In addition, the new law pursuant to the Notification of the Department of Labor Protection and Welfare, Re: Criteria, Measurement Method and Analysis of Measurement Results on Intensity of Hazardous Chemicals, B.E. 2559, specified that the measurement and analysis of measurement result must be performed at least once a year. This Notification has been announced on December 27, 2017 and it has been in full force and effect after 180 days after the announcement date.

2) Measurement and analysis of working conditions in relation of heat, light or noise by virtue of the laws on Notification of Department of Labor Protection and Welfare, Re: Criteria, inspection method and analysis of working condition concerning level of heat, light or sound including period of time and type of business required to be operated, B.E. 2550 (2017), which specified that measurement and analysis of measurement result must be performed at least once a year. In case there is an improvement or a change of machine, equipment, production process, work method or any operation which may impact to a change of level of heat, light or sound, the measurement and analysis of measurement result must be additionally performed within 90 days from the improvement date.

Useful sources for additional research on environment and health surveillance are in websites as follows:

- www.osha.gov
- www.cdc.gov/niosh
- www.epa.gov
- www.hse.gov.uk
-

6.1.4.2.2 Hierarchy of Control (HOC)

Hierarchy of Control (HOC) is selection order of control measures in working environment, which will be ranked from reliability, effectiveness and likelihood of reducing exposure, as follows:

- Elimination, for example, eliminate sulfur dioxide and pollutant particle emitted from stake of the plant by using clean energy;
- Substitution (replace a toxic chemical with a less toxic/hazardous one), for example, use soap instead of aromatic hydrocarbon solvents for cleaning;
- Engineering measure, for example, usage of local exhaust ventilation (laboratory fume hood) to suck pollution from sample analysis operation out of the laboratory;
- Administration, for instance, to specify operating procedures, provision of training and knowledge on work hazard;
- Personal protective equipment (PPE). Normally, PPE is regarded as the last measure that should be selected or it should be used jointly with other control measures because efficiency of PPE mainly depends on the person who wears it.

6.1.4.3 Documentation and communication of risk assessment result

Risk assessment documentation. It is necessary and essentially to keep risk assessment record systematically and correctly, including sequence of important activities and communication of risk assessment results to ensure that reduction of exposure has been positively changed and development of "zero illness" in the workplace. Therefore, the organization should consider and decide about keeping of health risk assessment records based on legal requirements and good practices, that is, such record should have:

- Adequate information, so that it can be confidently inspected on source of health risk assessment, background on work method and conclusion;
- Exposure measurement and health surveillance results;
- Compliance with the laws and the organizations' regulations;
- It can be used whenever needed, for instance, for internal and external inspection, inspection by the local or national official or it must be reviewed periodically within the organization;
- It must be kept at least for 30 years or as long as it is specified by the law, because these records can be used to assess health impact of the person and it is the assessment which required correctness, preciseness for insurance or legal prosecution in the future for the case of chronic health risks.

Communication of risk assessment results. Health risk assessment results should be communicated with all employees, and it should be regarded as a part of hazard and risk communication program, which can be performed via internet system within the organization (intranet), e-mail or newsletters of the organization, and etc.

6.1.4.4 Review and quality control of health risk assessment

Quality assurance and control, quality improvement and process documentation, health risk assessment are very important and they can be performed at both personnel level and business level through health and environmental management system.

Review of health risk assessment (HRA). HRA should be extensively reviewed by the third party agency every 5 year or when there is a change which may impact to health risk, including the change of production process and activities. If the assessment results suggest that new control measures are required, risk assessment should be performed again after control measures have been put in place for some time to ensure that risks are in acceptable level (risk appetite).

Quality control of health risk assessment. For quality control of HRA, the organization should specify operating standards about the health risk assessment. Health risk assessment process and health risk of each person should be regularly audited by the internal unit or the agency which does not have any interest with the organization. The audit should cover the followings:

- Administration management system and implementation of HRA;
- Existing and available sources for operations and for implementation of HRA;
- Amount and quality of HRA records;
- Remedy measures required after risk assessment;
- Efficiency and maintenance of control measures;
- Areas which have intensity or hazardous level higher than Occupational Exposure Limits (OELs);

- Document concerning operations and health history;
- HRA quality assessment by the experienced occupational health and hygiene personnel who do not work for the organization.

7. APPENDIX

แบบฟอร์ม การบันทึกข้อมูลการสัมผัสสิ่งที่เป็นอันตรายในการทำงาน

ชื่อพนักงาน _____ หน่วยงาน _____

จำนวนพนักงานหน่วยงาน _____ จำนวนพนักงานที่ทำงานนี้ _____

งานที่ทำ	สิ่งที่เป็นอันตรายที่สัมผัส	ลักษณะการทำงาน	ระยะเวลาที่สัมผัส	ความถี่ในการทำงาน	ทางเข้าสู่ร่างกาย	ผลกระทบสุขภาพ		มาตรการป้องกัน
						แบบเฉียบพลัน	แบบเรื้อรัง	
				ตารางที่ 7	(กิน สูดดม ตา ผิวหนัง)			ตามข้อ 4.2.4.2.2

แบบฟอร์ม บันทึกข้อมูลคัดกรองเพื่อจัด SEGs ของคนในแต่ละหน่วยงาน

ชื่อหน่วยงาน

ชื่อกิจกรรม #REF!

ชื่อบุคคล/งาน / อันตราย/สาร / ตำแหน่ง		#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!
0										
Shift A										
Shift B										
Shift C										
Shift D										

แบบฟอร์มการชี้บ่ง ประเมินความเสี่ยงด้านสุขภาพ

ตำแหน่งงาน_____หน่วยงาน_____จำนวนพนักงานหน่วยงาน_____จำนวนพนักงานที่ทำงานนี้_____

พื้นที่ปฏิบัติงาน (1)	ลักษณะการทำงาน (2)	อันตรายที่สัมผัส (3)			ระดับอันตราย (4)	ความถี่ในการสัมผัสอันตราย (5)	ระดับการสัมผัส (6) = (4) *(5)	ระดับความเสี่ยง (7) = (3) * (6)	วิธีการจัดการ (8)	หัวข้อการตรวจสุขภาพ (9)
		อันตรายจาก	ตัวชี้วัดอันตราย	ระดับความรุนแรง						
พิจารณาจาก ระเบียบการปฏิบัติงานการประเมินความเสี่ยงด้านสุขภาพ CP-HES-06 ---------->				ตารางที่ 1	ตารางที่ 2-6	ตารางที่ 7	ตารางที่ 8	ตารางที่ 9	ตารางที่ 10	ตารางที่ 11
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