GUIDELINE FOR HEAT MANAGEMENT OF DRYING PROCESS IN FIBER-CEMENT MANUFACTURING

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Thematic paper
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GUIDELINE FOR HEAT MANAGEMENT FOR DRYING PROCESS IN FIBER-CEMENT MANUFACTURING

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ABSTRACT

This study was a cross-sectional design which aimed to create guideline for heat management as required by Thai regulations. The heat at drying process of fiber cement manufacturing was higher than the standard. There were 12 sample employees from similar exposure group (SEG) for this study. The research methodology was consisted of 3 main steps (1) evaluation of requirements and regulations conformity for prescribing of appropriate working procedure conforming to the regulations (2) evaluation of working condition by collecting and investigating of heat sources, building structure, appropriate air ventilation system. Besides, the questionnaires and observation also were done including of incident data analysis, work load investigation, heart rate monitoring, body temperature and body weight of employees. (3) Summarization of collected data to develop guideline for heat management of drying process.

The study revealed that the company had performed to comply with the regulation but still found non compliances, e.g. risk assessment did not cover heat exposure, no manuals and work instructions caused untrained employees in heat exposure. A management guideline for heat at drying process was therefore created with 6 work instructions and 6 related documents.

The results of investigation of heat sources, building structure and air ventilation system indicated the appropriate ventilation system as local exhaust ventilation. The results of sample group study showed that heat cramp might be caused by heat in working area. The health monitoring was done by checking heart rate, body temperature and body weight which were within the safe range. However, an additional investigation in the hottest season of the year was recommended.

KEY WORDS: GUIDELINE / HEAT MANAGEMENT / DRYING PROCESS

91 pages

การจัดทำคู่มือบริหารจัดการความร้อนในกระบวนการอบแห้ง โรงงานผลิตไฟเบอร์-ซิเมนต์แห่งหนึ่ง

GUIDELINE FOR HEAT MANAGEMENT OF DRYING PROCESS IN FIBER-CEMENT MANUFACTURING

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บทคัดย่อ

การวิจัยนี้เป็นการศึกษาแบบภาคตัดขวาง มีวัตถุประสงค์เพื่อจัดทำคู่มือระบบบริหารจัดการความร้อน เพื่อใช้เป็นแนวทางในการนำไปใช้ปฏิบัติให้สอดคล้องกับกฎหมาย การวิจัยนี้ศึกษาการบริหารจัดการความร้อนในกระบวนการอบแห้ง ซึ่งมีระดับความร้อนสูงเกินมาตรฐาน กลุ่มตัวอย่างเป็นพนักงาน จำนวน 12 คน สุ่มตัวอย่างโดยวิธีจับกลุ่มผู้ปฏิบัติงานที่สัมผัสอันตรายคล้ายคลึงกัน วิธีการในการวิจัยแบ่งเป็น 3 ขั้นตอน ได้แก่ (1) การประเมินความสอดคล้องของกฎหมาย เพื่อกำหนดแนวทางปฏิบัติให้สอดคล้องกับกฎหมายและข้อกำหนด (2) การประเมินสภาพแวดล้อมในการทำงาน โดยการศึกษาข้อมูลของแหล่งความร้อน โครงสร้างอาคาร ระบบระบายอากาศที่เหมาะสม และเก็บข้อมูลของกลุ่มตัวอย่างโดยใช้แบบสอบถามและแบบสังเกตุ ข้อมูลที่ศึกษาได้แก่ อุบัติการณ์ย้อนหลัง ภาระงาน การเฝ้าระวังอันตรายจากความร้อนโดยใช้เครื่องมือวัดอัตราการเต้นของหัวใจ อุณหภูมิร่างกาย และน้ำหนักตัวของกลุ่มตัวอย่าง (3) รวบรวมข้อมูลที่ได้จากการศึกษามาจัดทำเป็นคู่มือระบบบริหารจัดการความร้อนในกระบวนการอบแห้ง ผลการวิจัยพบว่า บริษัทฯ มีการดำเนินการที่สอดคล้องกับกฎหมาย แต่พบประเด็นที่อาจจะส่งผลให้เกิดความไม่สอดคล้องได้ เช่น การประเมินความเสี่ยงไม่ครอบคลุมเรื่องอันตรายจากความร้อน , คู่มือและขั้นตอนการปฏิบัติงานกับความร้อนยังไม่ถูกจัดทำเป็นเอกสาร และทำให้ยังไม่มีการจัดอบรมให้พนักงานได้ทราบถึงอันตรายและการป้องกันอันตรายจากความร้อน ดังนั้นผู้วิจัยจึงจัดทำคู่มือบริหารจัดการความร้อนในกระบวนการอบแห้งขึ้น ประกอบด้วยคู่มือ 1 ฉบับ วิธีการปฏิบัติงาน 6 ฉบับ และเอกสารที่เกี่ยวข้อง 6 ฉบับ ในส่วนผลการศึกษาข้อมูลแหล่งความร้อน โครงสร้างอาคารและระบบระบายอากาศ พบว่าระบบระบายที่เหมาะสมได้แก่ระบบระบายอากาศแบบลมเย็นเฉพาะที่ ส่วนผลการศึกษากลุ่มตัวอย่างพบว่าอุบัติการณ์ที่เกิดขึ้น เช่น ตะคริว อาจเป็นผลมาจากความร้อนในสถานที่ทำงาน และการเฝ้าระวังทางสุขภาพโดยการตรวจวัดอัตราการเต้นของหัวใจ อุณหภูมิของร่างกาย และน้ำหนักตัวอยู่ในเกณฑ์ที่ปลอดภัย ทั้งนี้ควรศึกษาเพิ่มเติมในช่วงฤดูกาลที่ร้อนที่สุดของปีเพื่อประเมินอีกครั้งหนึ่ง

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CHAPTER I
INTRODUCTION

1.1 Principle and Background

The employees who expose to the heat are classified as working with risk factors by the ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment related to heat, light and noise B.E. 2549 (A.D. 2006). If the employee exposes to the heat continuously and accumulate for long time without balancing of heat between their body and environment, illnesses and disorders will be the consequences afterwards. Exposure to heat could cause heat rash, heat cramp, heat exhaustion and heat stroke.

This study is focusing on problems of occupational safety, health and environment in drying section area which is risky to heat. Heat in drying section area could be separated into 2 categories, heat from human metabolism and heat from working environment. The major sources of heat from working environment are including of natural gas combustion in the dryer, sun light and heat releases from fiber cement board.

It was found that heat in working area and environment in two recently monitoring results exceeded threshold limit of heat standard as shown in Figure1-1.

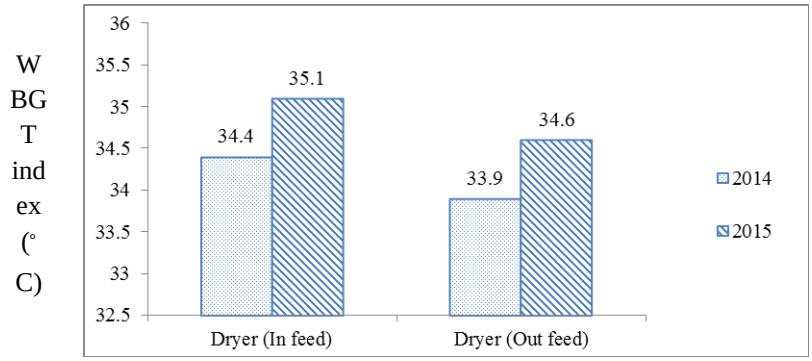


Figure 1.1 The results of heat monitoring in 2014 – 2015

According to the monitoring results, wet-bulb globe temperature (WBGT) index was higher than standard for moderate work (32ºC). Action plan for working condition improvement in engineering and management system is therefore needed. Now, the factory has a heat control measure starting from engineering aspect to receiver: installing ventilators, warning signs and PPE enforcement as stated in the ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment related to heat, light and noise B.E. 2549 (A.D. 2006). However, there are some lacking of some aspects such as:

- Determination of heat management policy
- Determination of role and responsibility of employees
- Determination of employee's competencies and capabilities
- Monitoring, assessment and work controlling

All aspects mentioned above consist of many details which are needed to be created as related documents as stated in section no.3 of the ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment related to heat, light and noise B.E. 2549 (A.D. 2006). Thus, it should to develop the guideline for heat management in drying process as required by the regulation.

1.2 Objectives

1.2.1 General objectives

- To assess conformity to the law and related regulations
- To assess the health risk of employees caused by heat exposure

1.2.2 Specific objective

- To develop the management manual of heat in drying section area

1.3 Scope of study

Define the scope of this study and develop a guideline standard by

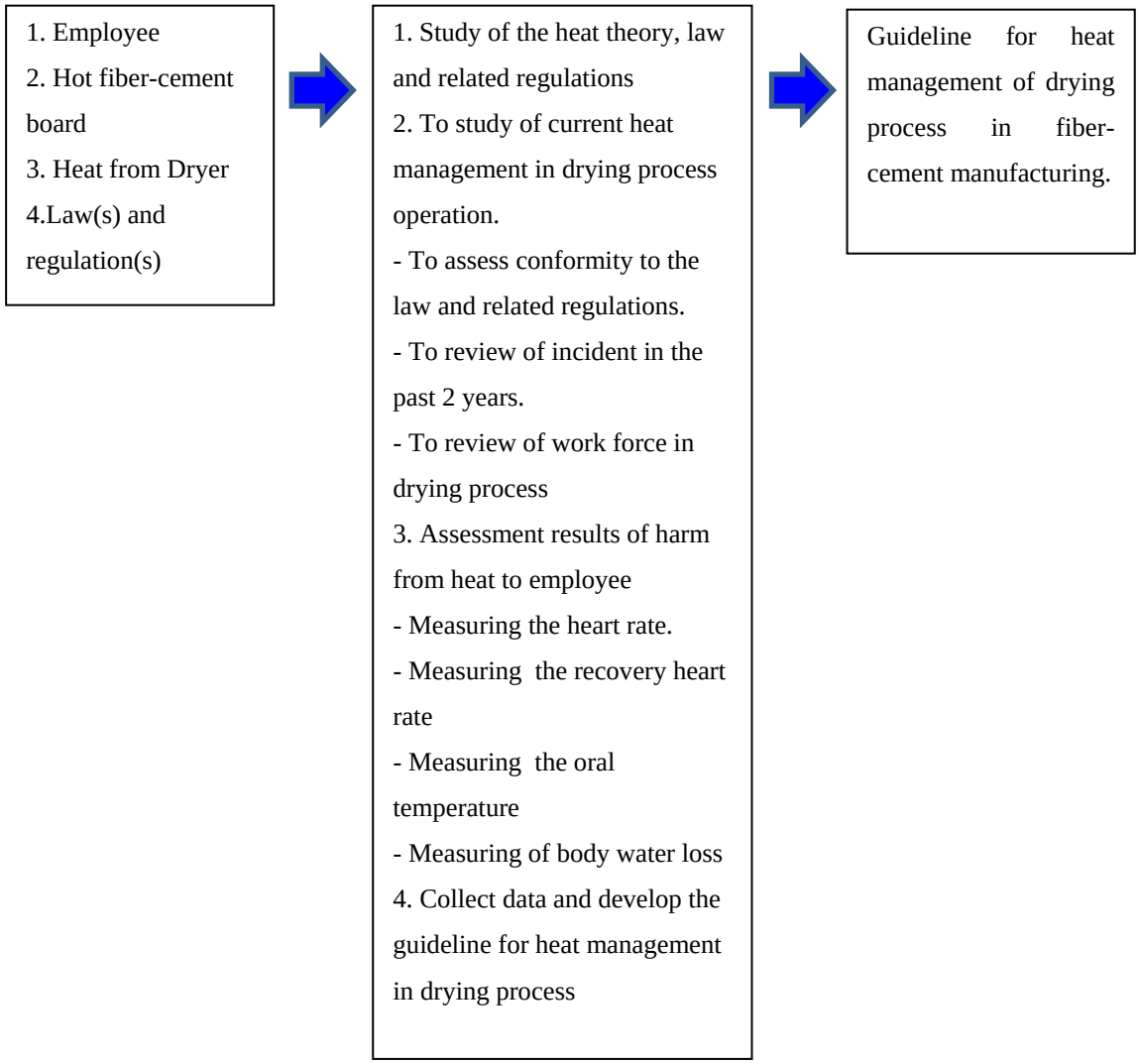
1.3.1 Study of the heat theory, law and related regulations

1.3.2 Study of current heat management in drying process operation

1.3.2 Study of related factors causing heat in drying process

1.3.4 Collect data and develop the guideline for heat management in drying process

1.4 Conceptual framework



1.5 Expected Benefits

The guideline for heat management in drying process is able to use as a management standard to prevent illnesses and accident from work as well as complying with the related law and regulations.

CHAPTER II
LITERATURE REVIEW

2.1 What is heat?

Heat is a kind of energy, transferable between substances or systems by its temperature gradient. The unit of heat is known in Joule (J.), Calorie (Cal.) or BTU, defining 1 calorie in terms of the energy using for rising up 1 ºC of 1 gram water at standard temperature (16.5 °C – 17.5 ºC). The relation between Joule, Calorie and BTU can be described below.

1 Cal. = 42 J, 1 BTU = 252 Cal.

2.2 The heat source of employee

2.2.1 Heat from metabolism, occurring in biochemical process inside cells and muscle tissues of human body. Whenever cells or muscle tissues are being under high intense loading, the metabolism will be raised up accordingly. The metabolism rate is shown in the table below.

Table 2.1 Metabolism rate in various activities

A. Body Position Movement	Kcal / min	
Sitting	0.3	
Standing	0.6	
Walking (Uphill)	2.0-3.0 (add o.8 Kcal / mater rise in elevation)	
B. Type of work	Average Kcal/min	Range Kcal/min
Handwork		0.2-1.2
Light	0.4	
Heavy	0.9	
Work one arm		0.7-2.5
Light	1.0	
Heavy	1.8	
Work both arm		1.0-3.5
Light	1.5	
Heavy	2.5	
Work whole body		2.5-9.0
Light	3.5	
Moderate	5.0	
Heavy	7.0	
Very heavy	9.0	

Source: OSHA Technical Manual .Section III: Chapter 4.Heat Stress [(1)]

2.2.2 Heat from environment or external heat. Typically, core temperature of human body is approximately to 37.5 ºC. If the external temperature is being very high, abnormal symptoms will be occurred to the human body. Heat exchange takes place between human body and environment in generally to maintain balances and stabilize core temperature. There are four ways of heat elimination from human body, including of heat radiation, heat conduction, heat convection and evaporation

2.3 Heat exchange between human and environment

The hypothalamus in human brain controls the body upon to the surroundings and keeping human core temperature stabilized at 37 ºC. When the body is heated up until core temperature is also raised, sweating and blood feeding into skin layer will be the consequences. There are four mechanisms of heat exchange between human and environment as describe following:

2.3.1 Radiation: The method contributed by temperature gradient between body and environment. In resting phase, the human body eliminates heat out by 60% at room temperature of 21ºC. In the other hands, if the surroundings temperature is higher, the body will get heat radiated from environment as well.

2.3.2 Conduction: The heat transmission by temperature gradient between body and environment through solid medium, for instance, touching metal with nippy feeling.

2.3.3 Convection: The heat transmission by temperature gradient between body and environment through liquid medium, such as air or water.

2.3.4 Evaporation: In resting phase, the human body loses 25% heat of total heat loss. During working phase of the employee, this mechanism is the most important heat transmission. Evaporation of sweat eliminates heat out from human body. Evaporation mechanism takes place whenever vapor pressure of water of the skin is higher than the air in its surroundings. The main cause of sweat evaporation is relative humidity namely, high relative humidity causes warming air and low evaporation will be the result which eventually causes low heat transmission rate from the body to surrounding. Moreover, fluid flow like water or wind around the body and surface area are also source of factors affecting evaporation as well.

2.4 Related regulations and standards

2.4.1 The legal framework which prescribes roles of government agencies, employer and employee for managing its organization up to hygienic practice complied with the ministerial regulation statement. This is also including of the employer and employee rights as well as action plan and documentation reporting to

related units. (The Occupational Safety, Health and Environment ACT B.E. 2554 (A.D. 2011),Government Gazette No.128 Section4, given on 12 January B.E. 2554) [2]

2.4.2 The regulation which prescribes standards for safety occupational health and working environment management. It defines roles of organization staff in each level for safety, prepares safety rules guidance and training as well as defines the accidents and occupational diseases reporting procedure. (The Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment B.E. 2549 (A.D. 2006), Government Gazette No. 123 Section 65, given on 21 June B.E. 2549) [3]

2.4.3 The regulation which prescribes heat management, standard heat WBGT in working space and working condition. Heat in working area is required to monitored and analyzed to be controlled within standard specified criteria. In case of unable to control the heat within the standard, working environment and condition need the engineering improvement, warning signs and health checking up preparation with reporting to the government agencies is required. (The Ministerial Regulation on The Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (A.D. 2006), Government Gazette No. 123 Section 23, given on 6 March B.E. 2549) [4]

Table 2.2 The monitoring area conditions and WBGT index calculation

Area Conditions	Calculation
No sunlight outdoor, or indoor	WBGT = 0.7 NWB + 0.3GT
Outdoor with sunlight	WBGT = 0.7 NWB + 0.2GT + 0.1 DB

Source : The Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment B.E. 2549 (A.D. 2006) [4]

Table 2.3 Work-load conditions, example cases and standard WBGT index

Work-Load Conditions	Example Cases	WBGT index (°C)
Light <200 Kcal/hr	Writing, typing, data keying, sewing, product inspecting	≤ 34
Moderate 200-350 Kcal /hr	Nailing, sharpening, driving or equivalents	≤ 32
Hard >350 Kcal/hr	Using a large hammer, lifting in an inclined-area or equivalents	≤ 30

Source : The Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment B.E. 2549 (A.D. 2006) [4]

2.4.4 The regulation which requires heat assessments and analysis in working space by employer with report preparation in the warmest month, once a year. Properties of monitoring devices, sampling procedures, calculation of average heat level as well as improvement of environment condition in case of monitored heat exceed specified standard, are defined. (Rule of The Department of Labour Protection and Welfare on the Prescribing of Criteria, Method and Work Condition Analysis in Relation to Heat, Light and Noise B.E. 2550 (A.D. 2007), Government Gazette No. 124 Special Section 76, given on 22 June B.E. 2550) [5]

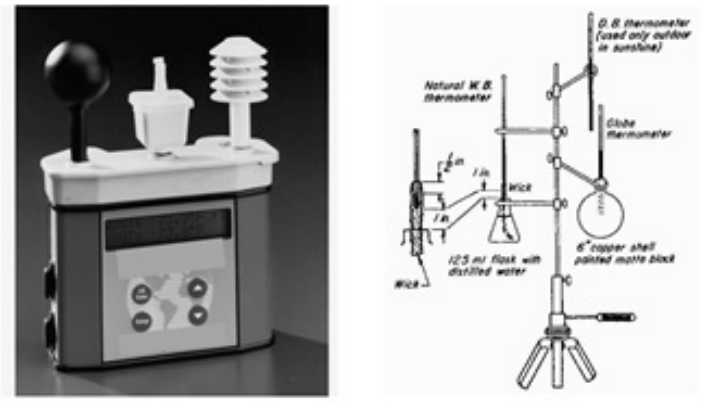


Figure 2.1 standard WBGT index monitoring devices

2.4.5 The regulation which requires the employer to prepare health checking up by risk factors to its employee who work with heat. The first checkup may hold within 30 days before start working, annual checkup, after job transferring or may request for the employee who leaves more than three days. The personal health checkup recording book is required as well as data storing and checkup results forwarding procedures to the labour inspector with action plan in case of abnormal results are also defined. (The Ministerial Regulation on The Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the Results of Health Check up to Labour Inspector B.E. 2547 (A.D. 2004), Government Gazette No. 122 Section 4, given on 13 January B.E. 2548) [(6)]

2.4.6 The regulation which prescribes personal health checkup book for employee who work with risk factors and reporting template of abnormal results, illnesses, medical treatments and preventive actions. (Rule of The Department of Labour Protection and Welfare on Prescribing of Personal Health Checkup Form of Employee Who Work with Risk Factors and Abnormal Results Reporting, Illness, Medical Treatments Form and Preventive Actions B.E. 2551 (A.D. 2008), Government Gazette No. 125 Special Section 30, given on 11 February B.E. 2551) [(7)]

2.4.7 ACGIH Threshold Limit Values (TLVs) for hot environment, as measured in wet bulb globe temperature index.[(8)]

These TLV's are based on the assumption that nearly all acclimatized, fully clothed workers with adequate water and salt intake should be able to function effectively under the given working conditions without exceeding a deep body temperature of 38°C. They are also based on the assumption that the WBGT Index of the resting place is the same or very close to that of the workplace. Where the WBGT of the work area is different from that of the rest area, a time-weighted average should be used

Table 2.4 ACGIH Threshold Limit Values for hot environment

Workload			
Work-Rest regimen	Light (ºC/ºF)	Moderate (ºC/ºF)	Heavy (ºC/ºF)
Continuous work	30 / 86	27 /80	25 / 77
75% Work 25% Rest , each hour	30.5 / 87	27.7 / 82	25.5 / 78
50% Work 50% Rest , each hour	31.6 / 89	29.4 / 85	27.2 / 82
25% Work 75% Rest , each hour	32.2 / 90	31 / 88	30 / 86

Source: ACGIH 1992 [8]

These TLV's apply to physically fit and acclimatized individuals wearing light summer clothing. If heavier clothing that impedes sweat or has a higher insulation value is required, the permissible heat exposure TLV's in Table 2.4 must be reduced by the corrections shown in Table 2.5

Table 2.5 Correction table of ACGIH Threshold Limit Values for hot environment

Clothing type	Clo* value	WBGT Correction
Summer light weight working clothing	1.08	0
Cotton coveralls	1.8	-3.6
Winter work Clothing	2.5	-7.2
Water barrier permeable	2.1	-6.9

Source: ACGIH 1992 [8]

2.4.8 ACGIH Action limit [9]

The energy expenditure of work load below the Action Limit is presumptively low stress for any healthy worker.

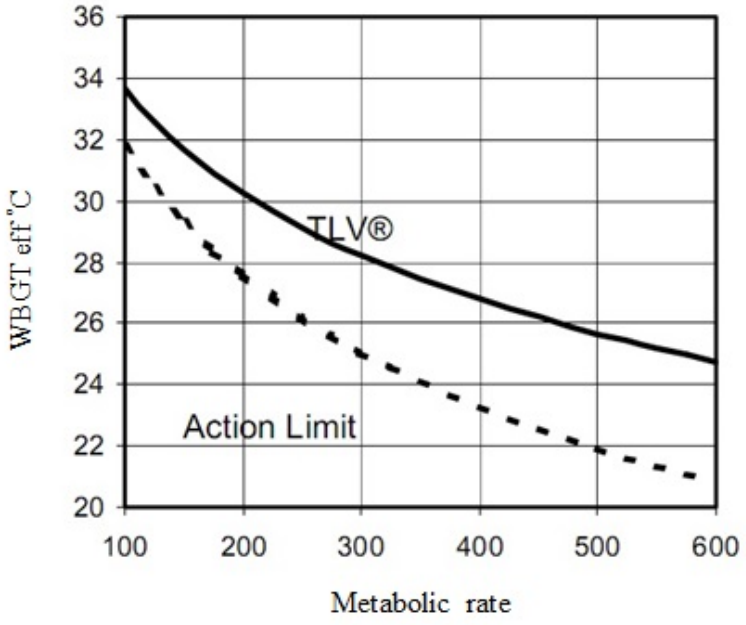


Figure 2.2 Action limit at various temperatures and metabolic rates [9]

2.5 Heat disorders and health effect [1,10,11]

2.5.1 Heat Stroke

Heat stroke caused by disordered-temperature controlling system of human body. That causes raising core temperature until threshold point is reached. It's hard to predict this phenomenon because there are many related factors. Heat stroke is the emergency illness. Hyperpyrexia, abnormal heart rate, confusing, dizzy, nausea and vomiting, sense loses, hot skin, earlier much sweating then fast evaporated, low blood pressure, core temperature exceeds 41°C, abnormal bleeding, hepatitis, kidney failure are the signs of heat stroke. The most severity of this illness is fatality.

If the employee has signs and symptoms of heat stroke, the employee should go–through medical treatment immediately by transferring to airy cold and

shady area, loosen the shirt, give hydration and contact emergency medical service. The opportunity of surviving depends on the patient's health and first aid.

The symptoms found in laboratory are presenting of uric acid in blood, high blood CPK, low blood platelets with Disseminate intravascular coagulation (severe case), respiratory alkalosis, low potassium in blood, myoglobin found in urine, low blood sugar, high blood Transaminase enzyme.

2.5.2 Heat Exhaustion

The symptoms are including of exhausted, headaches, nausea, confusing, core temperature exceeds 38 ºC with heat cramp, thermopolypnoea (some cases) causing respiratory alkalosis and eventually causes heat stroke. If sweating is reduced, patient should be rested in airy cool place, giving re-hydration by drinking water or electrolytes.

2.5.3 Heat Cramp

Heat cramp occurred by severely works in hot area, unbalanced electrolytes from sweat and mineral salts losing without appropriate rehydration. The symptoms are including of pains and muscle convulsion, typically happen in the late working period of the day and/or whenever immediately expose to cold climates or surrounding as bathing. The worst case is about Muscle Necrosis.

The symptoms found in laboratory are presenting of raised blood CPK and Creatine found in urine. The employee who works in hot area must rehydrate by drinking water in every 15-20 minutes with rest before taking bath or exposing cold climates.

2.5.4 Heat Syncope

The dilation of blood capillary under skin causing low blood pressure and finally resulted insufficient blood feeding to the brain, is almost occurred after severely works at least two hours. Cold skin, much sweating, light and fast pulse, under 100 mmHg blood pressures, normal core temperature are the symptoms.

Acclimatization is a program that makes employee able to adjust themselves to prevent this illness.

2.5.5 Heat Rashes

Congested or clogged perspiratory gland, generally occurred around the body, chest, back, breast, armpit and groin. If there is no proper medical treatment obtained, the infection will be the consequence. Heat rashes can be reduced if the climate is cooled down.

2.5.6 Heat Fatigue

Improper or lacking of acclimatization would be the factor contributing to this illness. Sensation disorder, decreased working efficiency are the symptoms. Heat fatigue has no medical treatment required, adjust working condition can help release this symptom.

2.6 Preventive measure and control of harm related to heat [12]

Center of disease control and prevention (CDC) prescribes harm controlling procedure called Hierarchy of control which is able to implement as describe following.

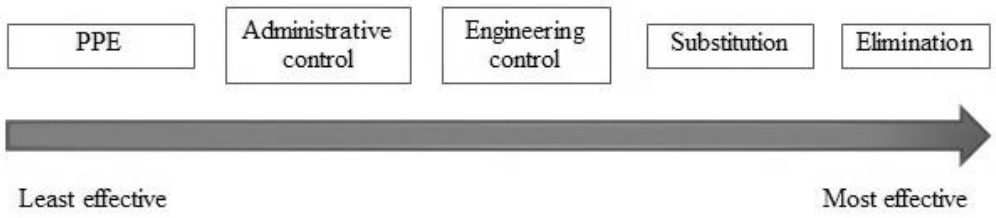


Figure 2.3 Hierarchy of control

2.6.1 Eliminate

Elimination of heat source is the most effective preventive measure and harm control because source of the harm is already controlled e.g. cancellation of production process where using of heat.

2.6.2 Substitution

Prevention and control by process modification, raw material, new tools or equipment for harm from heat reduction.

2.6.3 Engineering control

Engineering control of heat e.g. General Exhaust Ventilation [13], Air Cooling, Air Conditioning System, Local Exhaust Ventilation, Heat Insulation and using of heat shield.

2.6.3.1 General Exhaust Ventilation can be separated into two categories as following.

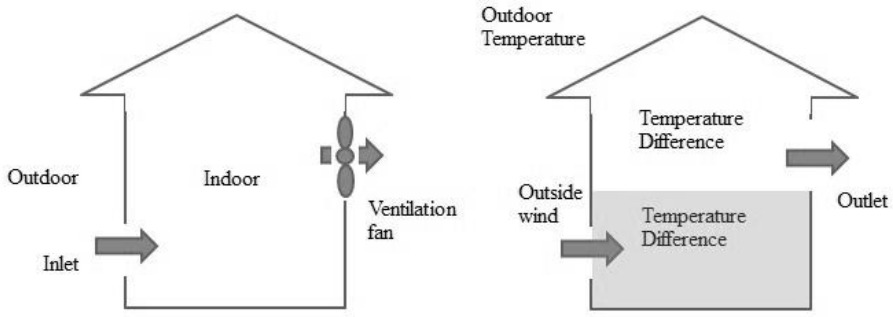


Figure 2.4 Mechanical and Natural General Exhaust Ventilation

2.6.3.2 Air Cooling, Air cooling has capacity limit at 30 tons, suitable for limited area of installation site or heat exchanger system.

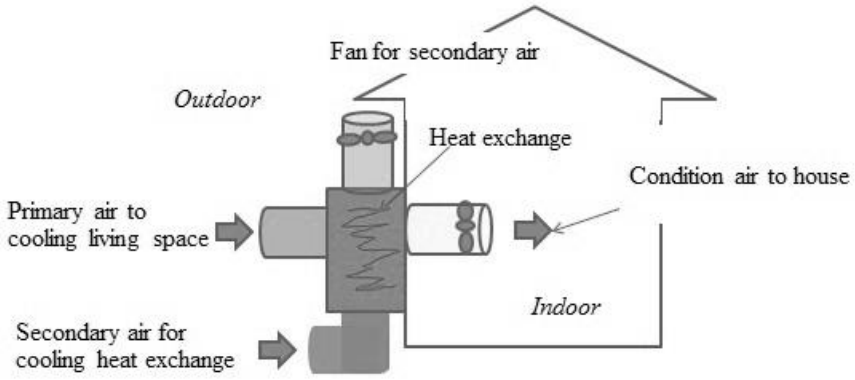


Figure 2.5 General Exhaust Ventilation by Air Cooling

2.6.3.3 Air Conditioning System

Air conditioner provides confort temperature control but the cost is rather high

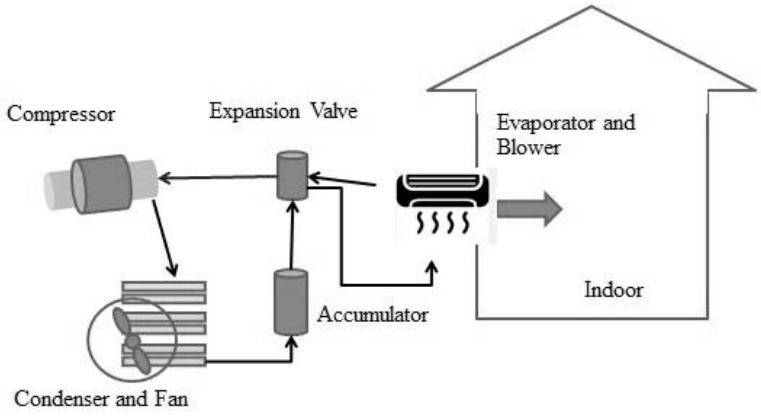


Figure 2.6 Air conditioner installation

2.6.3.4 Local Exhaust Ventilation

Local Exhaust Ventilation is a high efficiency ventilation system provided with energy saving friendly and cold lossless. Typically, it's composing of Hood, Duct System, Air cleaner and Fan.

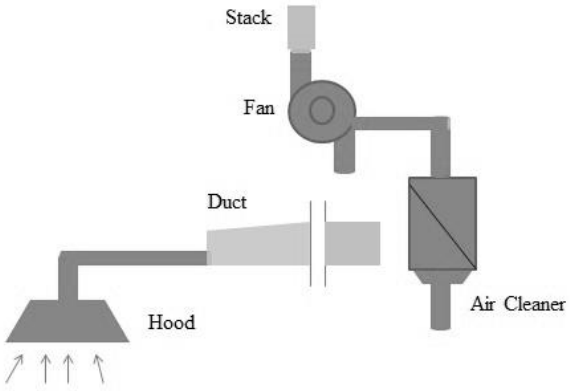


Figure 2.7 Local Exhaust Ventilation

2.6.3.5 Other heat preventions

Prevent heat exposure from conduction and radiation e.g. hot surface over 35 º C insulations, using heat shield ~~cremation panels~~ between employee and heat source, under roof insulations, using of heat prevention materials like interlocking bricks as building material.

2.6.4 Management system [14,15]

2.6.4.1 The employee readiness management

2.6.4.1.1 Screening of employee who is healthy, not present of obesity, blood pressure related, heart disease to work with heat as well as deserve annual health checkup.

2.6.4.1.2 Attend the proper acclimatization program e.g. 5 days acclimatization starting the first day at 50% work load then increasing to reach 100% in the fifth day. The employee who stop working over 2 weeks should get into the program again before starting to work.

2.6.4.1.3 Provide training in heat stress and prevention to the employees.

2.6.4.1.4 Specify working time and resting time and rotation of work in hot area.

2.6.4.2 Working with heat management

2.6.4.2.1 Hot work should be scheduled for the cooler part of the day, and routine maintenance and repair work in hot areas should be scheduled for the cooler season of the year.

2.6.4.2.2 Avoid extreme work e.g. heavy weight liftingin hot space area.

2.6.4.2.3 Provide rest area to the employees to rest between working period (e.g. airy and shady area, air-conditioned room).

2.6.4.2.4 Provide drinking water or electrolytes.

2.6.4.3 Monitoring of heat exposure

2.6.4.3.1 Check and monitor blood pressure, heart rate and sweating of the employee.

2.6.4.3.2 Check the heart rate of the employees after resting for 30 seconds, if over 110 beats/ minute, reduce working time should be considered to one-third of the total and provide them a resting period.

2.6.4.3.3 Check the heart recovery rate by investigating heart rate at first 30 seconds of the resting period (P1) compare to the heart rate after 2.5 minutes rested (P3) referring to this table below.

Table 2.6 Heart Recovery Rate Table

Heart Recovery Rate Table	P3	P3-P1
Good efficiency	<90	-
Normal efficiency	90	10
Abnormal efficiency	90	<10

Source : OSHA Technical Manual, Section III: Chapter 4, Heat Stress[1]

2.6.4.3.4 Check under tongue temperature of the employee by using thermometer before drinking water. If exceed 37.6ºC, it should be considered to reduce working time in next schedule work.

2.6.4.3.5 Check the weight of the employee before and after working, should not decrease more than 1.5% in a day. Too much sweating causes higher weight decreasing rate.

2.6.5 Personal protective equipment

Choose a proper personal protective equipment (PPE) to a specific heat source e.g. aluminize suit for high radiation area.

Figure 2.8 Heat prevention suit

2.7 Application of "SolidWorks" Software for ventilation system simulation [16]

SolidWorks is the software program which its work flow simulation function is generally used to calculate a fluid in pipe flow rate or electronic parts cooling. As mentioned in thesis titled Simulations for Improvement of Ventilation System in Mild Steel Factory, the author [16] used this program to simulate air flowing in the factory which is able to deliver simulation results similar to the actual measured values. This program is also applied for this study, as shown in figure 2-9.

Figure 2.9 Application of SolidWorks software for room temperature simulations [16]

2.8 Occupational Health and Safety Management System (OHSAS 18001) [17]

Occupational Health and Safety Management System is one of international standard like ISO 9001 and ISO 14001. The structure of this management system is running on deming cycle, i.e., Plan-Do-Check-Act (PDCA). The current version is OHSAS 18001:2007.

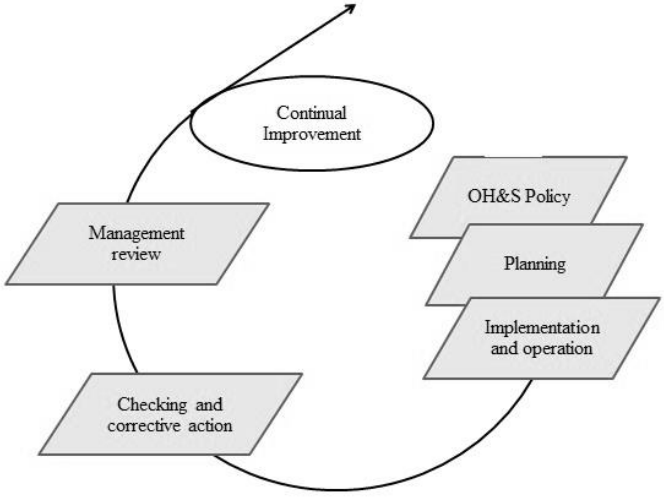


Figure 2.10 Main elements of the OHSAS 18001

2.9 Drying process information in this study

2.9.1 Lamination processes

Including of 4 main stages as following (shown in Fig. 2.11):

2.9.1.1 Fiber preparation stage is the process that re-slushing fiber sources (e.g. papers, pulp sheets) takes place in the hydra-pulper to separate them into individual fiber. This stage delivers cellulose fiber.

2.9.1.2 Final mixing stage is the mixing process between cellulose fiber, cement and some additives. This stage delivered final slurry.

2.9.1.3 Lamination stage bring the final slurry to the lamination felt where transferring to the forming drum became fresh board. Then support each single fresh board by template metal sheet, board by board.

2.9.1.4 Drying stage is the process where cured-fresh board be dried up to specified standard.

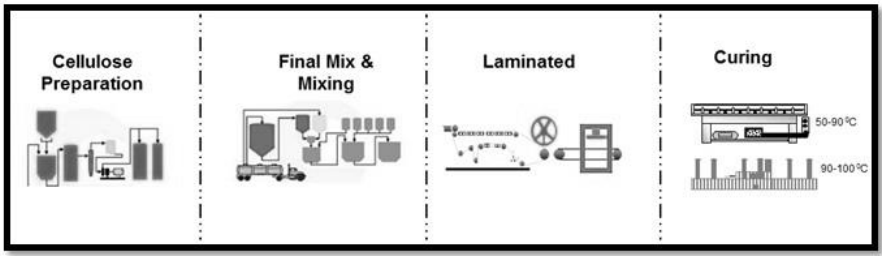


Figure 2.11 Lamination Processes

2.9.2 Finishing processes

There are 4 main stages as following (shown in Fig. 2.12):

2.9.2.1 Sanding stage is the sanding process to texturizing real wood grain to its surface.

2.9.2.2 Cutting stage is the station for cutting the big sheet board to be desired in various dimensions.

2.9.2.3 Grooving stage is the process that grooves or chamfers.

2.9.2.4 Coloring and packing stages. The board will be painted by automatic machine and transfers to be packed into individual bundle before shipping.

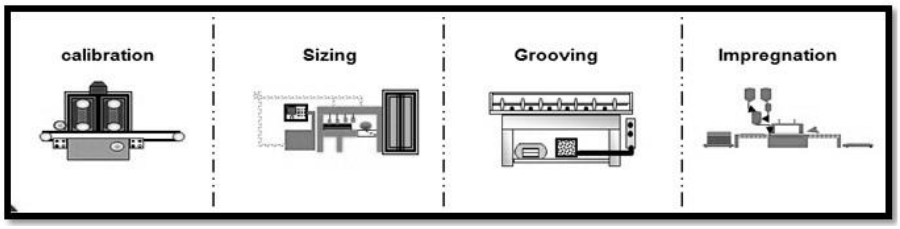


Figure 2.12 Finishing processes

2.10 Related literatures

2.10.1 Egkachai Wimon (2007) [16] studied about heat and its transferring from the furnace to the working circumstances, contributed to over the standard level temperature. He also studied of fluid dynamics and used SolidWorks software to calculate the model of effective ventilation system installation and eventually brought the reduction of temperature to comply with the regulation. The information was useful for investigation of the local exhaust ventilation system and could be the guideline for ventilation system design.

2.10.2 Ramphal-Naley L.(2012) [18] studied about factors affecting the change of human body core temperature in employees and athletes. Then used these factors with a purpose of screening people who expose to heat. The main two factors were Environmental factors (environmental stress index, or ESI) (e.g. relative humidity, ray from the sun, environment temperature) and Personal factors (personal stress index, or PSI) (e.g. age, gender, heart and blood system, taken drug, wearing cloth). The proposed factors were medical questionnaire, blood pressure, BMI and if the age was over or equal to 35 years, EKG and ESI were also included. It was able to utilize the personal factors of this mentioned study to screen the employee who has to work at drying process.

2.10.3 Habibolah Dehghan et al.(2012) [19] studied the evaluation of stress and strain from heat in 71 employees of 2 petroleum chemical factories by using WBGT index, Heart rate monitor and PSI. It was found that the average WBGT index was at 33 ºC which higher than suggested value of ACGIH, and proposes that suggested working time – resting time at ACGIH was not proper for heat management. But after evaluated with PSI, the results were low-moderate strain. He, therefore, summarized that the PSI evaluation was more proper than WBGT in his study. It is able to utilize the results of this mentioned study to find the way to evaluate for health-concerns monitoring other than WBGT index.

2.10.4 Chan R-TLaC-C (2009) [20] studied the effects of heat on construction, agricultural and fisheries worker,Historical data relating to meteorology, population, the labour force and economy were obtained from publicly available databases from the Taiwanese government.It was found that higher than 30 ºC for the average temperature with over 74% RH in most area of Taiwan will affects the worker.

2.10.5 Mahant S(2015) [21] reviewed the heat stroke by mentioning symptoms, epidemiology, mechanisms, human body temperature controlling system, clinical manifestations and first aid treatments.

CHAPTER III
METHOD

3.1 Research format

This research is a cross-sectional study base focusing on investigation of heat management at drying process which is currently run. Then develop guideline for heat at drying process management.

3.2 Population

3.2.1 Population and sample set

Employee who works in drying division, 2 shifts with 24 staffs.

3.2.2 Sample

Sample set of this study is the morning shift 12 employees of drying division (08:00 – 20:00).

3.2.3 Sampling method

Sampling by grouping of similar exposure group (SEG), i.e., all of morning shift employee accounted for 12 persons, because employees in day-time shift is exposed to the heat from the sun which contributes to higher temperature than night shift.

3.3 Tool and equipment

3.3.1 Personal computer, Acer aspire 4930 with 32-bit Windows 7 OS

3.3.2 Microsoft Office 2010

3.3.3 Canon IXUS 130 digital camera

3.3.4 Blood Pressure Monitor, Omron HEM-7203

3.3.5 Weighing balance

3.3.6 Clinical thermometer

3.3.7 Related standards and regulations

3.3.8 Questionnaires and observation forms

3.4 Research steps

3.4.1 Investigate occupational health and safety problems of the factory and select the interested problem to focus and create guideline. The heat at drying process area is selected in this study.

3.4.2 Investigate principles, regulations, requirements and research related to heat and management.

3.4.3 Create thesis proposal of introduction, literature review and research method.

3.4.4 Prepare for appointing of thesis proposal advisor and attend the proposal defense meeting.

3.4.5 Propose the thesis title to the faculty of graduate studies for approval.

3.4.6 Propose for morality of human research to the faculty of graduate studies for approval.

3.4.7 Data collecting permission was allowed by proposing letter to the manufacturing and quality management manager from the faculty of public health, Mahidol University.

3.4.8 Conduct the research by following method stated in item 3.5.

3.5 Research method

3.5.1 Review current heat management

3.5.1.1 Evaluate regulations and requirements conformity to find the non-conformity. Conduct the non-conformity assessment then summarize the assessment result by following descriptive statistics with presenting of assessment summary. The related requirements and regulations are consisted of these following items.

3.5.1.1.1 The occupational safety, health and environment act B.E. 2554 (A.D. 2011)

3.5.1.1.2 The ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment in relation to heat, light and noise B.E. 2549 (A.D. 2006)

3.5.1.1.3 The ministerial regulation on the prescribing of criteria and method of conducting health check up of employees and forwarding the results of health check up to labour inspector B.E. 2547 (A.D. 2004)

3.5.1.1.4 The rule of the department of labour protection and welfare on the prescribing of personal health checkup report form of the employees who work with risk factors and forwarding results report form B.E. 2551 (A.D. 2008)

3.5.1.2 Review preliminary information about building structure, materials and tooling, ventilation system and temperature with summarization by using descriptive statistics e.g. explanation, averaged value, frequency distribution table and propose the proper ventilation system by the expert from hired agency.

3.5.1.3 Review incidents information related to heat occurred to employees who work at drying process in 2 years back. Descriptive statistics are used to illustrate data in frequency distribution table form.

3.5.1.4 Review employee’s information who works at drying process e.g. amount, gender, age range, height, education background and congenital disease that sensitive to heat. Then do the overall summarization by using descriptive statistics with presenting of the frequency distribution table

3.5.2 Collect data for monitoring harm from heat and finding for appropriate working time and resting time.

3.5.2.1 Check and record heart rate of the employee after rated for 30 seconds. If the heart rate is found higher than 110 beats/ minute, next working time will be advised to one-third reduced. Blood pressure monitor, Omron model HEM-7203 was used for checking heart rate. Do the checking again after completed of work cycle in the afternoon then analyze by using descriptive statistics e.g. explanation and frequency distribution table.

3.5.2.2 Check and record heart recovery rate by using the blood pressure monitor, Omron model HEM-7203 to check the first 30 seconds after rested (P1) compare with 2.5 minutes after rested (P3). The difference between P1 and P3 should higher than 10 beats/minute. Do the checking again after completed of work cycle in the afternoon then analyze by using descriptive statistics e.g. explanation and frequency distribution table.

3.5.2.3 Check the arm pit temperature by using clinical thermometer, done by in charged nurse of the company while resting period of the employee in the afternoon, avoid checking after drinking. If the temperature is found higher than 37.6 ºC, next working time will be advised to one-third reduced. Then analyze by using descriptive statistics e.g. explanation and frequency distribution table.

3.5.2.4 Check and record the employee's weight before and after working, should not be differed higher than 1.5% of a day. If the difference is high, that might be too much sweating. Then analyze by using descriptive statistics e.g. explanation and frequency distribution table.

3.5.3 Collect data to set the heat at drying process management guideline which is consisted of these following:

3.5.3.1 Roles and responsibilities along the heat management system should be set to the executive officers through operators.

3.5.3.2 Working instruction of the employee who work with heat at drying process management, including of:

- Qualification of drying division staff check list

- Training program and manual, covering to introduction to heat, harm of heat, diseases related to heat, protection of harm from heat and action plan in emergency case related to heat

- Acclimatization program for new staffs and staffs who stopped working in hot area or rotational to and from other section more than 2 weeks

3.5.3.3 Working procedure on specified working time with heat.

3.5.3.4 Working procedure on monitoring of employee's health who work at drying process, specify monitoring steps of before, during and after working.

3.5.3.5 Working procedure on level of heat at drying process audit, specify monitoring device standard, qualification of the auditor, criteria and monitoring method, sampling procedure and area.

3.5.3.6 Working procedure on personal protective equipment for employees who work with heat, specify proper personal protective equipment provided at drying process.

3.5.3.7 Working procedure on warning signs and symbol related to harm of heat at drying process, specify standard of installation point as well as symbol and mentioned message formats. Then create guideline of standard management system with PDCA cycle.

3.5.4 Propose the final completed heat at drying process management guideline.

CHAPTER IV
RESULT

The steps of study, reviewing and data collecting are consisted of:

4.1 Review current heat management.

4.1.1 Evaluation of regulations and requirements conformity.

4.1.2 Evaluation of working conditions.

4.1.2.1 Area and building structure.

4.1.2.2 Heat sources.

4.1.2.3 Investigate proper ventilation format.

4.1.3 Review incident data in 2 year back.

4.1.4 Review status of staffs at drying process.

4.1.4.1 Interviewing results.

4.1.4.2 Working characteristics and working procedure data.

4.2 Evaluation of working time and resting time suitability by using the health monitoring program for employees.

4.2.1 Heart rate monitoring result at resting after stop working.

4.2.2 Evaluate the heart recovery rate.

4.2.3 Monitor the body temperature after shift work.

4.2.4 Monitor the body weight of employees

4.3 Develop the management guideline for working in hot environment at drying process by using data obtained from literature reviewing, clause 4.1 and 4.2, as detailed below.

4.1 Review current heat management

4.1.1 Evaluation of regulations and requirements conformity.

There are 6 regulations and requirements related to heat management were reviewed as described below.

4.1.1.1 The Occupational Safety, Health and Environment ACT B.E. 2554 (A.D. 2011) which is the legal framework prescribes roles of government agencies; employer and employee for managing its organization up to hygienic practice complied with the ministerial regulation statement. This is also including of the employer and employee rights as well as action plan and documentation reporting to related units.

It was found that mostly conformed to, except some aspects which is needed to be adjusted – Section 14 prescribes the role of the employer to inform the harm conditions to the employees as well as provides working procedure or working manual with notifying and training but no working manual provided.

Section 16 prescribes the role of the employer to provide training related to occupational safety, health and environment to all employees. There was a general training but not specific for working in hot area as well as Section 32 which prescribes the role of the employer to evaluate harms that already conducted but no working in hot environment specified.

4.1.1.2 The ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment B.E. 2549 (A.D. 2006) which the regulation prescribes standards for safety occupational health and working environment management. It defines roles of organization staff in each level for safety, development of safety rules guidance and training as well as defines the accidents and occupational diseases reporting procedure.

It was found that clause 3 prescribes the role of the employer to provide rules and safety guideline for working with provide training to the employees to work safely as well as monitor and enforcement control. It was the rules and safety guideline for working provided but not cover harms related to heat including clause 5 specified for new employee.

4.1.1.3 The Ministerial Regulation on The Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (A.D. 2006) which is the regulation prescribes heat management, standard heat WBGT in working space and working condition. Heat in working area is required to monitored and analyzed to be controlled within standard specified criteria. In case of unable to control the heat within the standard, working environment and condition need the engineering improvement, warning signs and health checking up preparation with reporting to the government agencies is required. It was found that already conducted and conformed to the regulations.

4.1.1.4 Regulation of the Department of Labour Protection and Welfare on the Prescribing of Criteria, Method and Work Condition Analysis in Relation to Heat, Light and Noise B.E. 2550 (A.D. 2007) which is the regulation requires heat assessments and analysis in working space by the employer with report preparation in the hottest month, once a year. Properties of monitoring devices, sampling procedures, calculation of average heat level as well as improvement of environment condition in case of monitored heat exceed specified standard, are defined. The company already conducted and conformed to the regulations.

4.1.1.5 The Ministerial Regulation on the Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the Results of Health Check up to Labour Inspector B.E. 2547 (A.D. 2004) which is the regulation requires the employer to provide health checking up by risk factors to its employee who work in hot environment. The first checkup may hold within 30 days before start working, annual checkup, after job transferring or may request for the employee who leaves more than three days. The personal health checkup recording book is required as well as data storing and checkup results forwarding procedures to the labour inspector with action plan in case of abnormal results are also defined. The company already conducted and conformed to the regulations.

4.1.1.6 Rule of The Department of Labour Protection and Welfare on Prescribing of Personal Health Checkup Form of Employee Who Work with Risk Factors and Abnormal Results Reporting, Illness, Medical Treatments Form

and Preventive Actions B.E. 2551 (A.D. 2008) which is the regulation prescribes personal health checkup book for employee who work with risk factors and reporting template of abnormal results, illnesses, medical treatments and preventive actions. The evaluation of regulations conformity results was shown in the table 4.1 below.

Table 4.1 The evaluation of regulations conformity results.

Requirements	Evaluation Results	Remark
1. The Occupational Safety, Health and Environment ACT B.E. 2554 (A.D. 2011)		
Section 6 prescribes the role of the employer to provide its organization to comply with the ministerial regulation statement.	Conformed	
Section 7 prescribes the role of the employer to pay all the handling cost.	Conformed	
Section 8 prescribes the role of the employer to conduct conforming to the specified in the ministerial regulations.	Conformed	
Section 14 prescribes the role of the employer to inform the harm conditions and provides working manual to the employees.	Conformed	There were notifications and training but no working manual provided.
Section 16 prescribes the role of the employer to provide training course related to occupational safety, health and environment to all employees.	Conformed	There are no training course specific to working in hot area.
Section 17 prescribes the role of the employer to post warning signs with role and responsibilities of employer and employee.	Conformed	
Section 20 prescribes the role of the executive staffs to cooperate with employer to conduct occupational safety, health and environment activities.	Conformed	
Section 21 prescribes the responsibility of the employee to take care of working condition and environment. If broken and/or damage issues are found, reporting to supervisor should take place immediately.	Conformed	
Section 22 prescribes the role of the employer to provide PPE, and prescribes the role of the employees to put on the provided PPE.	Conformed	
Section 23 prescribes the role of the contractor and subcontractor to follow this regulation.	Conformed	

Table 4.1 The evaluation of regulations conformity results. (Cont.)

Requirements	Evaluation Results	Remark
1. The Occupational Safety, Health and Environment ACT B.E. 2554 (A.D. 2011)		
Section 32 prescribes the role of the employer to evaluate harms and investigate the effects of working environment condition with create working plan related to safety and report the handling results to the director-general.	Conformed	There is no working in hot environment risk assessment.
2. The Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment B.E. 2549 (A.D. 2006)		
Clause 3 prescribes the role of the employer to provide regulations and safety manual for working, provide training to employee to work safely and monitoring enforcement.	Conformed	Harms of heat are not specified in the rules and safety manual for working.
Clause 5 prescribes the role of the employer to provide training to new staffs or rotated staffs.	Conformed	Harms of heat are not specified in the rules and safety manual for working.
Clause 7 prescribes the role of the employer to appoint safety officer in supervising level.	Conformed	
Clause 16 prescribes the role of the employer to appoint safety officer in professional level	Conformed	
Clause 19 prescribes the role of the employer to appoint safety officer in managing level.	Conformed	
Clause 23 prescribes the role of the employer to set up the safety committee.	Conformed	
Clause 29 prescribes the role of the employer to call the safety committee for corrective and preventive investigation in case of occurring of harm or accident to the employee.	Conformed	
Clause 33 prescribes the role of the employer to set up the occupational safety, health and environment unit.	Conformed	
Clause 35 prescribes the role of the employer to appoint the head of occupational safety, health and environment unit.	Conformed	

Table 4.1 The evaluation of regulations conformity results. (Cont.)

Requirements	Evaluation Results	Remark
2. The Ministerial Regulation on the Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment B.E. 2549 (A.D. 2006)		
Clause 38 prescribes the role of the employer to do lettering report to the director-general within 30 days in case of harms, losses or illnesses occurring to the employee.	Conformed	
3. The Ministerial Regulation on The Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (A.D. 2006).		
Clause 3 prescribes the standard of heat level in working area i.e. light work load at 34 ºC, moderate work load at 32 ºC and heavy work load at 30 ºC.	Conformed	
Clause 4 If the monitoring results are higher or lower than specified value in the ministerial regulation, root causes as well as preventive and corrective protocol with action time frame should be specified.	Conformed	Ventilation fan is installed, electrolyte beverages are provided, warning signs are also posted.
Clause 13 PPEs for hot work, uniform clothes, shoes, gloves must be made from light weight material and resist heat to prevent body temperature exceed 38 ºC.	Conformed	
Clause 14 prescribes the role of the employer to manage PPEs systematically as well as trains the employee regarding using PPE and always able to be audited.	Conformed	
Clause 15 prescribes the role of the employer to monitor and analyze heat level in the organization.	Conformed	
Clause 16 prescribes the role of the employer to do the monitoring and analysis report with has to be acknowledged by the safety officer in professional level.	Conformed	
Clause 21 prescribes the role of the employer to provide health checkup to the focus group of the employees.	Conformed	

Table 4.1 The evaluation of regulations conformity results. (Cont.)

Requirements	Evaluation Results	Remark
3. The Ministerial Regulation on The Prescribing of Standard for Administration and Management of Occupational Safety, Health and Environment in Relation to Heat, Light and Noise B.E. 2549 (A.D. 2006).		
Clause 22 prescribes the role of the employer to provide immediately medical treatment to the employee in case of abnormal or illnesses occurred with finding for causes and submit the health checkup summary report to the director-general within 30 days after found.	Conformed	
4. Rule of The Department of Labour Protection and Welfare on The Prescribing of Criteria, Method and Work Condition Analysis in Relation to Heat, Light and Noise B.E. 2550 (A.D. 2007).		
Clause 3 prescribes the role of the employer to evaluate and analyze working conditions related to heat, light and noise once a year.	Conformed	
Clause 4 prescribes the procedure of heat evaluation to take place in the hottest month of the year.	Conformed	
Clause 5 prescribes the organization type in needed to do the evaluation.	Conformed	
Clause 6 prescribes all the heat evaluation devices must be able to read WBGT comply with ISO 7243 and also be calibrated before use.	Conformed	
Clause 7 prescribes all the heat evaluation devices to be installed at chest level, leave 30 minutes before read value and calculate WBGT as the ministerial regulation specified, average the value in 2 hours of hottest working period.	Conformed	
Clause 16 If the monitoring results are higher than specified value in the ministerial regulation, root causes as well as preventive and corrective protocol with action time frame should be specified.	Conformed	Ventilation fan is installed, electrolyte beverages are provided, warning signs are also posted.

Table 4.1 The evaluation of regulations conformity results. (Cont.)

Requirements	Evaluation Results	Remark
5. The Ministerial Regulation on The Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the Results of Health Check up to Labour Inspector B.E. 2547 (A.D. 2004).		
Clause 2 prescribes the definitions of risk factors which work in hot environment meets definition in (4).	Conformed	
Clause 3 prescribes the role of the employer to provide health checkup plan to the employee who work with risk factors done by first class medical doctor with Diploma of Thai Board of Occupational Medicine or certified in training. First checkup must be done within the first 30 working days and redone every year. In case of work rotation, health checkup must be done within first 30 working days after rotating.	Conformed	
Clause 4 In case of harm or illness occurred to the employee causing stop working over 3 days, the employer might consult with doctor to do health checkup before the employee get back to work.	Conformed	
Clause 5 prescribes the doctor to check and record the results with comments health condition of the employee who works with risk factor.	Conformed	
Clause 6 prescribes the role of the employer to provide personal health checkup record of the employee in all checkups.	Conformed	
Clause 7 prescribes the role of the employer to keep personal health checkup record of the employee for auditing within 2 years after stop hiring. In case of litigations, should be kept although more than 2 years until the case ends.	Conformed	
Clause 8 prescribes the role of the employer to inform the abnormal checkup result to the employee within 3 days or within 7 days in case of normal results delivered.	Conformed	

Table 4.1 The evaluation of regulations conformity results. (Cont.)

Requirements	Evaluation Results	Remark
5. The Ministerial Regulation on The Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the Results of Health Check up to Labour Inspector B.E. 2547 (A.D. 2004).		
Clause 9 prescribes the role of the employer to give immediately medical treatment to the employee in case of abnormal, illnesses in relation to work and do the investigation for causes with provide corrective and preventive actions as well as inform these abnormal situations to the director-general within 30 days.	Conformed	
Clause 10 prescribes the role of the employer to rotate the employee to another proper work in case of declaration of medical certificate from accredited hospital or government organization by the employee who is unable to work on current duty.	Conformed	
Clause 11 prescribes the role of the employer to give personal health checkup record back to the stopped-hiring employee	Conformed	
6. Rule of the Department of Labour Protection and Welfare on Prescribing of Personal Health Checkup Form of Employee Who Work with Risk Factors and Abnormal Results Reporting, Illness, Medical Treatments Form and Preventive Actions B.E. 2551 (A.D. 2008)		
Clause 3 prescribes the personal health checkup record to be complied with this rule.	Conformed	
Clause 4 prescribes the format of the health checkup results of the employee who found in any abnormal or illnesses, medical treatment, corrective and preventive action to comply with the informing health checkup result template with attached to this rule.	Conformed	

4.1.2 Evaluation of working condition.

4.1.2.1 Area and building structure

The drying section building located on the approximately 1,800 square meters, consists of two 15 meters height buildings with 9 meters height wall. The structure was built from cement block, siding metal sheets, louver, metal sheet covered roof with 6 ventilators on the left of the building. There was an entrance opened with closed in the end of the building. The first building was equipped with 4 dryers and 1 dryer in the second.

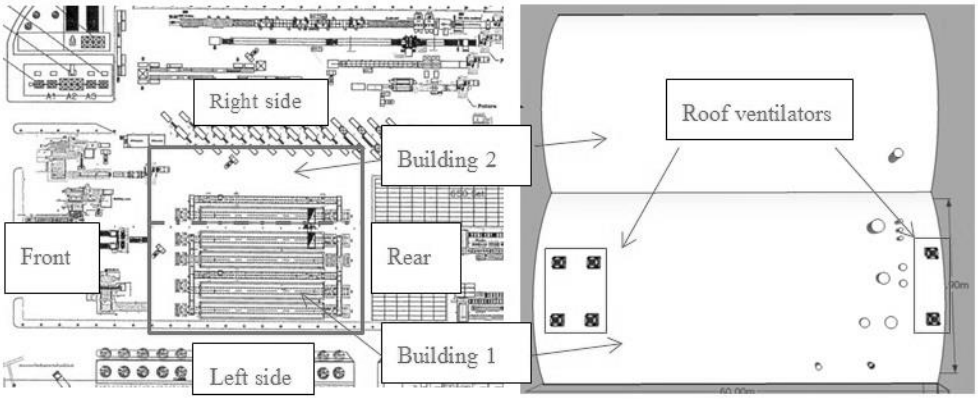


Figure 4.1 The drying section layout

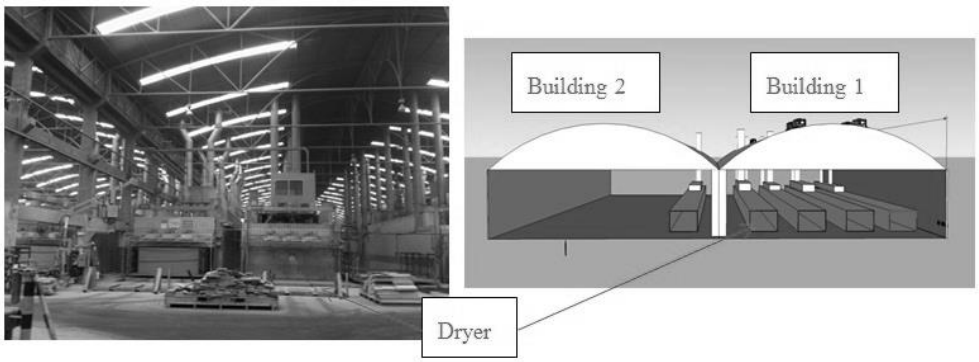


Figure 4.2 The drying section in front view.

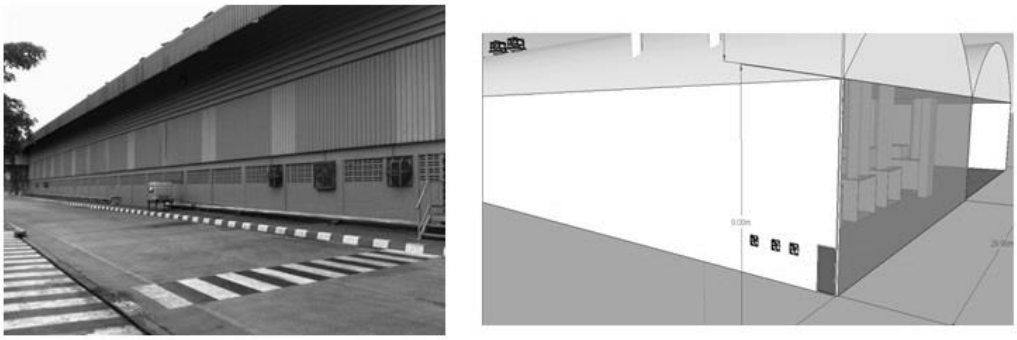


Figure 4.3 The drying section in left view.

Figure 4.4 Inside the drying section.

4.1.2.2 Heat sources

4.1.2.2.1 Sunlight is the natural heat source. In summer, the dry globe temperature is being around 40 ºC. It causes fatigue to the employee

4.1.2.2.2 Heat from the dryer surface, normally being around 31 ºC to 37 ºC

4.1.2.2.3 Once the dryer door was opened, a hot air and steam released to the working space

4.1.2.2.4 The product after drying would hold the heat around 38 ºC to 47 ºC which was able to release to the atmosphere

Figure 4.5 Temperature at dryer surface

Figure 4.6 Hot air and steam released to the working space once the door opened

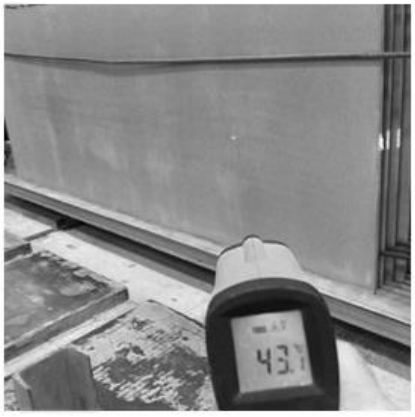


Figure 4.7 Heat from the board after drying.

4.1.2.3 Investigate the appropriate air ventilation due to the employee was stationed at the same position almost all the time of working. Air cooling system in spot cooling type was therefore recommended from Water Line Company as the proper system to be installed in the site. The mentioned system would be installed on the left side of the building and transfer coldness along with the pipe then spread out to the stationed position of the employee. This system reduces the temperature to be 25 ºC to 26 ºC.

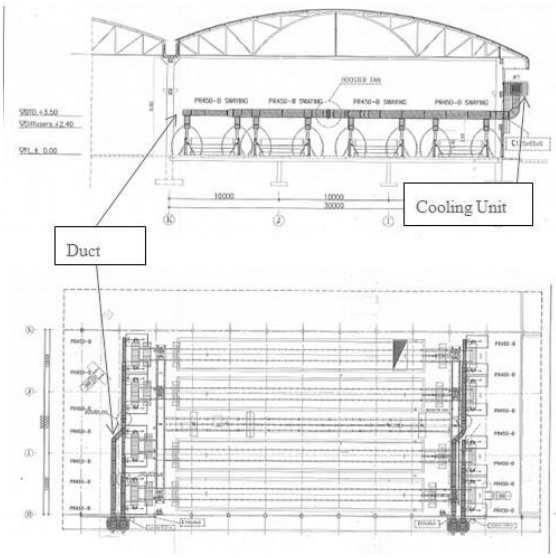


Figure 4.8 Air cooling system in spot cooling type.

4.1.3 Incident review in 2 years back.

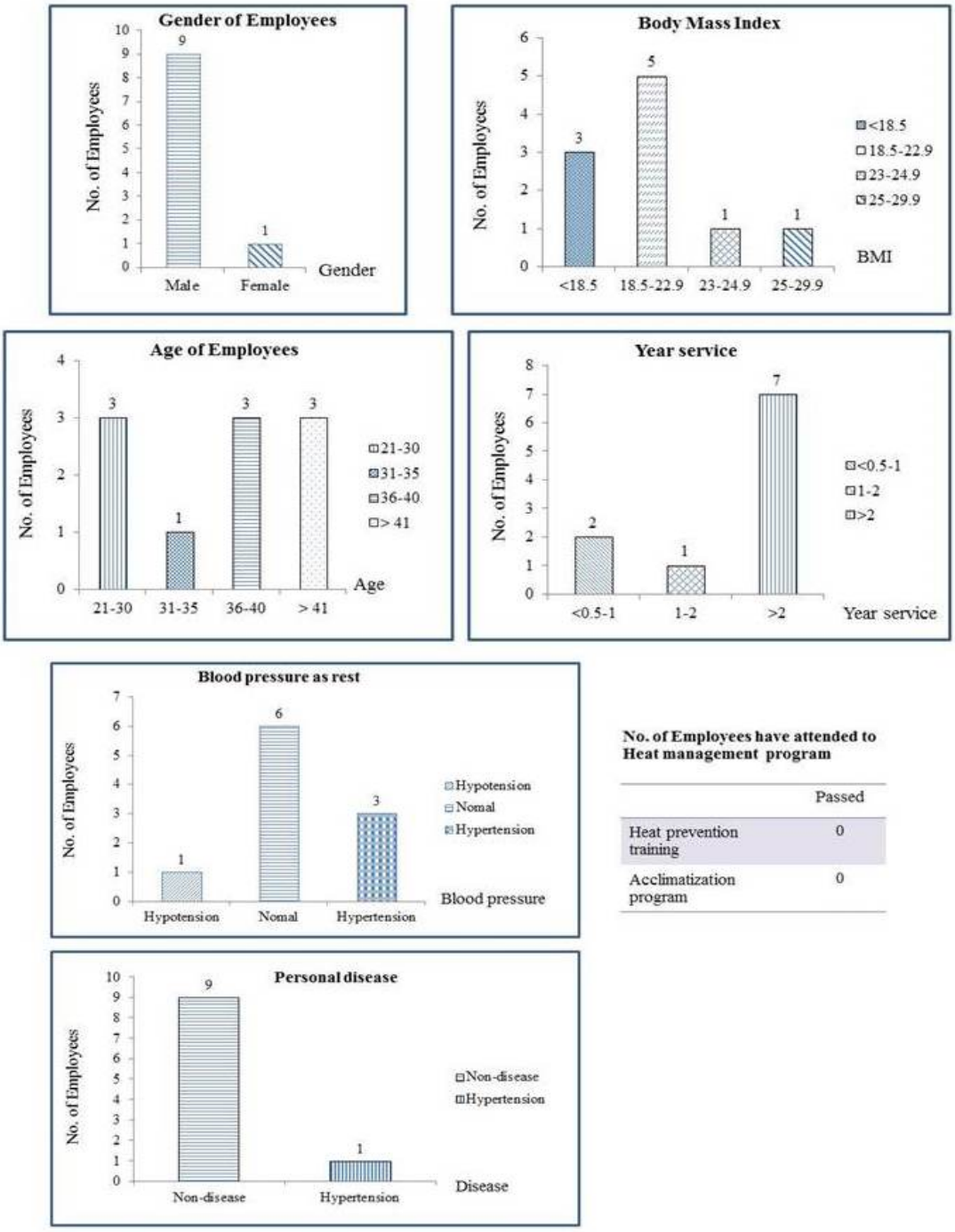
With interviewing results, it was found that there are 9 incidents occurred in 2 years back as shown in table 4.2.

Table 4.2 Incidents at drying section in 2 years back

	Incident	Count
1	Heat rash (Medical Treatment)	1
2	Heat rash (First Aid Treatment)	3
3	Backache	2
4	Become feverish	1
5	Accident	2

4.1.4 Reviewing of the employee's at drying process status.

4.1.4.1 After interviewing with the employee who works at drying process, it was found that:



No. of Employees have attended to Heat management program

	Passed
Heat prevention training	0
Acclimatization program	0

Figure 4.9 Status of employees who works at the drying process.

4.1.4.2 Working characteristic and working procedure information.

- Working time was separated into 2 shifts, 12 hours with 12 staffs per shift

- Working characteristics look alike manually lift the board into and out of the car, considered as moderate work load as shown below

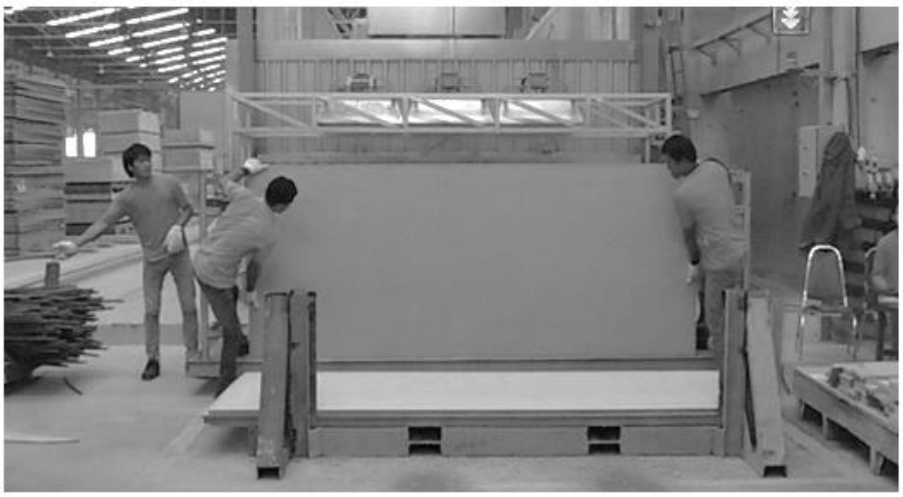


Figure 4.10 Lifting board into the dryer characteristic

- Board thickness affects the board lifting and transferring time into and out of the car as shown in table 4.3

Table 4.3 Board lifting and transferring time into and out of the car information

Thickness (mm)	Sheet weight (kgs)	Sheets/ Car	Car Pushing Time (mins)	Cars/ shift
8	40	30	24	20
11	55	30	24	20
14	70	26	26	16
16	80	26	26	16
20	100	20	34	14
22	110	20	34	14
25	125	18	40	12
30	148	18	40	12

4.2 The appropriateness of working time and resting time evaluation by the health monitoring for employee program.

4.2.1 Heart rate monitoring results at resting state after working. The employee rested after working in the afternoon for 30 seconds and checked the heart rate. If higher than 90 beats/minutes the working time should be reduced 1/3 of the total. The results were shown in table 4.4.

Table 4.4 Heart rate of the employee after 30 seconds rested

Level	Heart rate (beats/min)	Staff count
1	< 60 -90	9
2	91 - 100	1
3	101- 110	0
4	>110	0

4.2.2 Check heart recovery rate by monitoring heart rate after 30 seconds rested (P1) then after 2.5 minutes rested (P3) to be compared. The difference should higher than 10 beats/minutes (P3 should lower than P1 at least 10 beats/minutes). The results of heart recovery rate were shown in table 4.5.

Table 4.5 Heart recovery rate data.

Staff no.	Heart rate at resting state (beats/min)	Heart rate after 30 seconds rested (P1, beats/min)	Heart rate after 30 seconds rested (P1, beats/min)	P1-P3
1	68	64	70	-6
2	79	89	90	-1
3	94	96	96	0
4	73	82	80	2
5	74	82	84	-2
6	68	70	68	0
7	87	68	68	0
8	82	80	78	2
9	91	88	87	1
10	49	65	63	2

4.2.3 Body temperature measurement by using clinical thermometer check at arm pit temperature at resting state after ending of the working session in the afternoon. If higher than 37.6 ºC, the working load in next session should be reduced. This procedure should be done by in charged nurse of the factory. The results were shown in table 4.6.

Table 4.6 Data of the employee's body temperature after shift work.

Staff no.	Temperature (°C)	Remark
1	37.3	
2	36.7	
3	36.9	
4	37.7	Higher than suggested value
5	37.4	
6	36.8	
7	37.1	
8	36.7	
9	36.9	
10	35.7	

4.2.4 Measure the employee body weight. After working, the weight should not be reduced than 1.5% due to too much sweating. The weighing results were shown in table 4.7.

Table 4.7 The employee body weight, before and after shift work.

Staff no.	Before	After	% Before – After	Remark
1	60	60	0	
2	54	54	0	
3	60	61	1.6	
4	51	50	-2	More reduced than suggested value
5	55	56	1.7	
6	50	50	0	
7	62	63	1.6	
8	62	62	0	
9	55	55	0	
10	56	55	-1.8	More reduced than suggested value

Figure 4.11 Measure the heart rate, body temperature and weight for health monitoring.

4.3 Develop a management guideline for working in hot environment at drying process by summarizing reviewed literature data together with clause 4.1 and 4.2 by these steps shown below.

a. Guideline for heat at drying process management

b. Work instruction of management of staff who work in hot environment at drying process

c. Work instruction of working hours of works related to heat

d. Work instruction of monitoring of health of employee who works at drying process

e. Work instruction of heat at drying process evaluation

f. Work instruction of personal protective equipment

g. Work instruction of warning signs and symbols related to heat in drying process area as summarized in table 4.8.

Table 4.8 Non-conforming summarization and required documents that will be created by company

	Non-conforming	Clauses	require documents that will be created
1	No rules and safety manual for working in hot environment.	Evaluation of regulation conformity in the ministerial regulation for management B.E. 2549 which prescribes to have the rules and safety manual for working.	Guideline for heat management.
2	Inform and train the employee for heat understanding.	Evaluation of regulation conformity in the occupational safety, health and environment act B.E. 2554 which prescribes to inform the harm risks and provide training to employees.	Training session related to harms from heat.
3	According to the monitoring results, wet-bulb globe temperature (WBGT) index was higher than standard for moderate work. Action plan for working condition improvement in engineering and management system is therefore needed.	Evaluation of regulation conformity in the ministerial regulation on the prescribing of the standard for administration and management of occupational safety, health and environment in relation to heat, light and noise B.E. 2549 which there are no prescribing of standard of warning signs and appropriate PPEs provided	- Work instruction for PPEs - Work instruction for warning signs and symbols related to harm of heat in drying process area
		Results of investigation of the proper air ventilation system, inappropriate air ventilation system found.	Propose appropriate air ventilation system in the local exhaust ventilation
		- Review the status results of employee at drying process - Review incident data in 2 years back - Results of investigation of the proper air ventilation system, inappropriate air ventilation system found.	- Work instruction for management of staff who works at drying process - Work instruction for working hours of work related to heat - Work instruction for health monitoring of employee who works at drying process - Work instruction for evaluation of heat level at drying process

From table above, the guideline for heat at drying process management and working steps are therefore defined. The structure of the guideline is described in figure 4.12

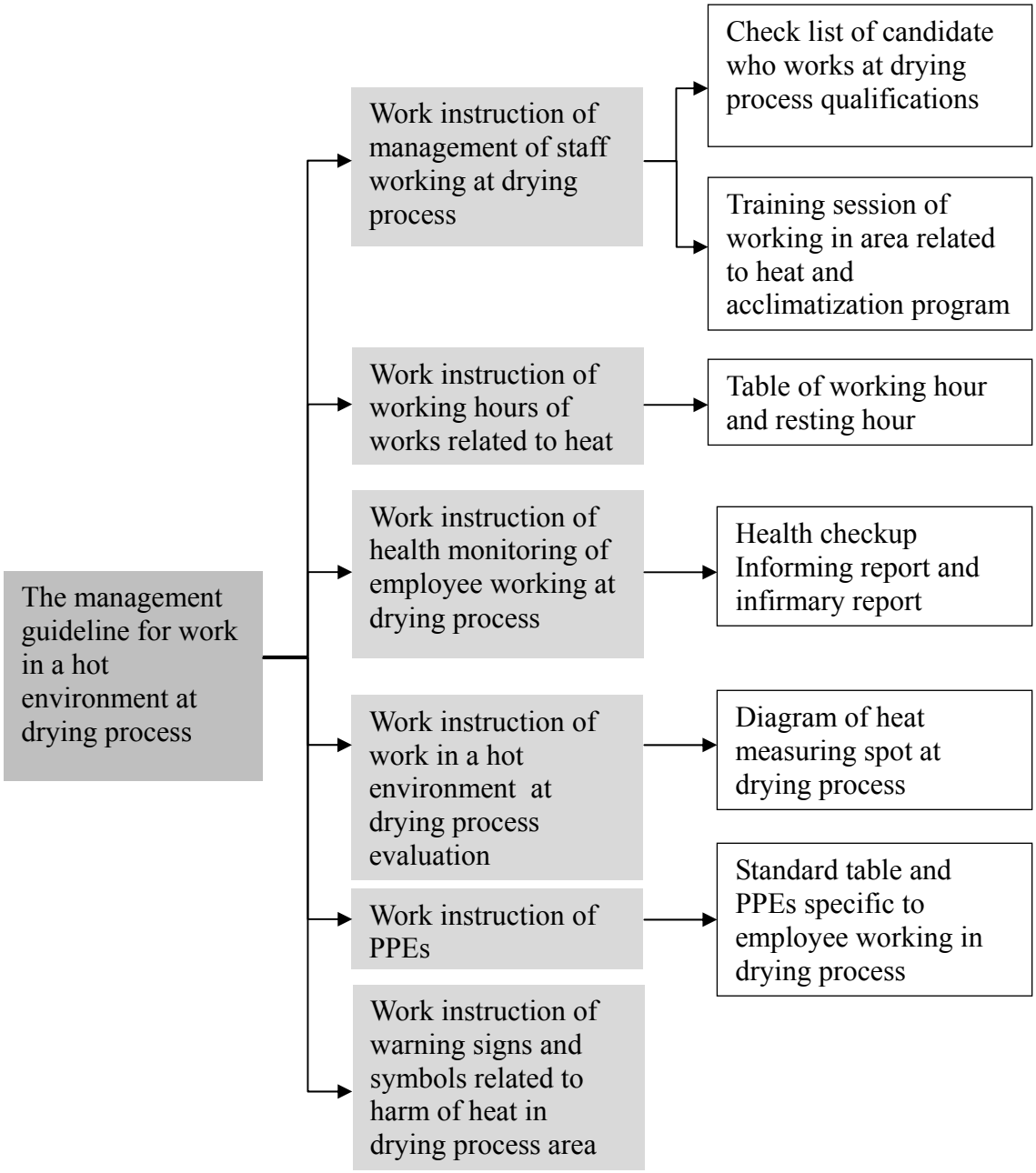


Figure 4.12 The structure of the guidelines

Guidelines for heat at drying process management

Preface

The occupational health, safety and environment task is classified as health supporting, harm and diseases preventing task to the employees. To maximize the efficiency of its operation, the handling steps should be done systematically with clearly appoint the in charge person for each step. This guideline for heat at drying process management is therefore created.

Scope

The guideline for heat at drying process management is used as the standard for heat management. The steps and work instructions specified in this guideline are enforcing to all employees, contractors and all related parties.

Policy

The company is engrossed in heat at drying process management to be complied with requirements and regulations by support budgets, staffs, preventive with reducing and controlling technology and conduct continuously improvement for healthy employees, contractors and all related parties.

Objectives

1. To follow requirements and regulations in relation to occupational health, safety and environment.

2. To use as rules and guidelines for harms and disease prevention from work to the employee.

Table 4.9 Roles and Responsibilities

Position	Responsibility
Line function	
Vice President	1. To be appointed as safety officer in management level. 2. Support budgets and resources for safety tasks. 3. Prescribe policies objectives of occupational health, safety and environment. 4. Control and monitor all level of safety officers.
Vice President production and quality management	1. To be appointed as safety officer in management level. 2. To be the head of occupational health, safety and environment committee. 3. Check and review working plan of safety tasks. 4. Control and monitor all level of safety officers. 5. Check and approve safety manual.
Plant 1 Manager	1. To be appointed as safety officer in management level. 2. Check and review working plan of safety tasks. 3. Control and monitor all level of safety officers. 4. Check and preliminary approve for working procedure and safety rules.
Production engineer	1. To be appointed as safety officer in supervising level. 2. Identify harms and evaluate risks together with safety officer in professional level. 3. Control and monitor all employees and contractors to follow working procedure and safety rules. 4. Check working and equipment condition as well as correct the found weakness. 5. Create safely work instructions. 6. Provide the on the job training for employees and contractors. 7. Adjust working condition to be safely and suitable for work.
Shift Supervisor / Supervisor leader	1. To be appointed as safety officer in supervising level. 2. Identify harms and evaluate risks together with engineers and safety officer in professional level. 3. Control and monitor all employees and contractors to follow working procedure and safety rules. 4. Check working and equipment condition as well as correct the found weakness.

Table 4.9 Roles and Responsibilities (Conts.)

Position	Responsibility
Line function	
Operator	1. Follow working procedures and safety rules. 2. Report problem and weakness to shift supervisor or engineer.
Managing director of Sub-Contractor	1. To be appointed as safety officer in management level. 2. Support budgets and resources for safety tasks. 3. Prescribe policies objectives of occupational health, safety and environment. Control and monitor all level of safety officers.
Sub-Contractor Supervisor	1. To be appointed as safety officer in supervising level. 2. Identify harms and evaluate risks together with engineers and safety officer in professional level. 3. Control and monitor all employees and contractors to follow working procedure and safety rules. 4. Check working and equipment condition as well as correct the found weakness.
Sub-Contractor	1. Follow working procedures and safety rules. 2. Report problem and weakness to shift supervisor or engineer.
Support function	
Occupational health and safety Committee	1. Review manual, working procedures and safety rules for approval. 2. Review risks lists and safety working plan for approval. 3. Follow the results of the occupational health, safety and environment handling and report to the Vice President
Human resource department	1. Create working procedure of management of employee who works in hot environment at drying process together with occupational and safety section and follow the working steps.

Table 4.9 Roles and Responsibilities (Conts.)

Position	Responsibility
Support function	
Occupational and safety section	1. Propose the plan of occupational health, safety and environment to the safety committee. 2. Support tasks of occupational health, safety and environment to be done together with other parties. 3. Summarize annual working result and proposal for improvement. 4. Prescribe standard and requirement of using equipment and PPE together with production engineer.
Safety officer professional	1. Identify harms and evaluate risks together with engineers and shift supervisor. 2. Train safely working steps to employees and the management committee. 3. Evaluate and analyze working condition. 4. Check working safety. Report and conduct incident investigation and propose corrective and preventive guideline to safety committee.

Working Procedure

1. In case of new employee present at drying process, the work instruction for management of employee who works in hot environment at drying process should be followed. The main topics are included of:

- Check the specified qualifications
- Provide the training session of occupational health, safety and environment and working in hot environment by safety officer in professional level.
- Provide on the job training by engineer
- Employees are needed to attend acclimatization program

2. Engineer and the shift supervisor have to control the employee to follow working time and resting time requirement as described in work instruction of working hour of works related to heat.

3. Health monitoring of employee who work in hot environment must be done by following the work instruction of health monitoring of the employee who works at drying process as detailed below.

- Provide drinking water and electrolyte beverage especially in summer
- Production engineer and shift supervisor check readiness and abnormal symptom of the employee before and after working in all shifts. In case of any abnormal symptoms found, should investigate together with safety officer in professional level
- Production engineer check all equipment to ensure safe working
- Safety officer in professional level investigate the incidents and illnesses occurred at drying process and analyze for the tendency with reporting to plant 1 manager
- Safety officer in professional level and human resources department provide health checkup by risk factor and report to regulation-related in needed parties

4. Prescribe to check and analyze working in hot environment condition once a year and report to the related government unit by following the work instruction of working in hot environment at drying process evaluation.

5. Engineer and shift supervisor are in charged for PPEs providing to all employees by following work instruction of PPEs.

6. Engineer is in charged for safety communication by posting warning announcement, safety symbols in working in hot environment by following work instruction of warning signs and symbols related to heat at drying process.

7. The safety committee and occupational safety section check and review handling results by following this guideline for improve the handling steps and report to the vice president once a year.

Related Documents

1. Work instruction of management of employee working in hot environment in drying process.

2. Work instruction of working hour of works related to heat.

3. Work instruction of health monitoring of the employee working at drying process.

4. Work instruction of heat at drying process evaluation.

5. Work instruction of personal protective equipment.

6. Work instruction of warning signs and symbols related to heat at drying process.

Work Instruction
of
The Management of Employee working in hot environment
in Drying Process

Scope

Work instruction of management of employee working in hot environment in drying process is used to control the management of employees and contractors working at drying process which covering since recruitment process and employee readiness preparation.

Table 4.10 Working flow diagram

Working steps	Production engineers	HR	Safety officer	Related document
1. Production engineer, who in charge at drying process, create man power count in needed to ask for additional from human resources department.				
2. Human resources department recruits qualified staff and contractor by using the qualification for employee who works at drying process check list.				The check list of qualification for employee who works at drying process.
3. Provide safety training session regarding occupational health, safety and environment to selected employees and contractors.				
4. Provide safety training session related to work in hot environment.				Training session related to work in hot environment.
5. Provide on the job training by production engineer who in charge at drying process.				
6. Employees and contractors who attended acclimatization program.				Acclimatization program.
7. Employees and contractors are able to work normally.				

Working Steps

1. Production engineer, who in charge at drying process, create man power count in needed to ask for additional from human resources department.

2. Human resources department recruits qualified staff and contractor by using the qualification for employee who works at drying process check list.

3. Provide safety training session regarding occupational health, safety and environment to selected employees and contractors.

4. Provide safety training session related to work in hot environment.

5. Provide on the job training by production engineer who in charge at drying process.

6. Employees and contractors who attended acclimatization program.

7. Employees and contractors are able to work normally.

Related Documents

1. The check list of qualification for employee who works at drying process.

2. Training session related to working in hot environment.

3. Acclimatization program.

The check list of qualification for employee who works at drying process

Personal Information

Name ..... Gender.....

	Yes	No
1. Age 18 - 50 years old	□	□
2. BMI is in appropriate level	□	□
3. No high blood pressure, blood vessel in brain and heart related	□	□

I hereby certify that the foregoing is true .....

Candidate

.....HR Department

Training

1. Completed the training session regarding occupational health, safety and environment.

Date .....

2. Completed the training session related to work in hot environment.

Date .....

Accredited ..... Safety Officer, Professional level

3. Completed on the job training.

Date .....

Accredited ..... Production Engineer

Acclimatization Program

Attend Acclimatization Program of the..... session Dated.....to Dated.....

Accredited..... Production Engineer

I hereby certify that the mentioned candidate above fulfilled with the qualifications to work at drying process since .....

.....HR Department

Safety training session of working in hot environment

1. Objectives

To emphasize understanding of working at drying process to employees and contractors regarding heat, harms from heat, disease from working in high heat area, prevention of harms form heat and emergency protocols.

2. Target Group

Employees who work at drying process.

3. Content

2 hours training session included of:

- The meaning of heat
- Harms from heat
- Disease from heat and prevention method
- Emergency protocols

What is heat?

Heat is a kind of energy which is used in normal life and works. Heat could be transformed and be transferred between circumstances by conduction, convection, radiation, evaporation and human metabolism.

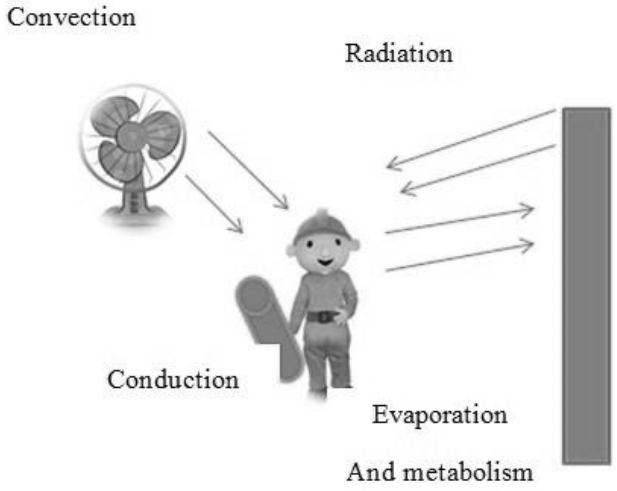


Figure 4.13 Heat transferred

Standard of heat in works

The ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment in relation to heat, light and noise B.E. 2549 prescribed the standard of heat as shown below.

- Light work load, WBGT shall not exceeded 34 ºC
- Moderate work load, WBGT shall not exceeded 32 ºC
- Heavy work load, WBGT shall not exceeded 30 ºC

By the mentioned work load above, works at drying process is classified as moderate, the WBGT shall not be exceeded 32ºC.

Heat monitoring shall be conducted in the hottest month of the year with recording of average heat value in 2 hottest hours in a day.

Heat – related illness

Once the human body is exposed to the high level of heat, would be resulted as:

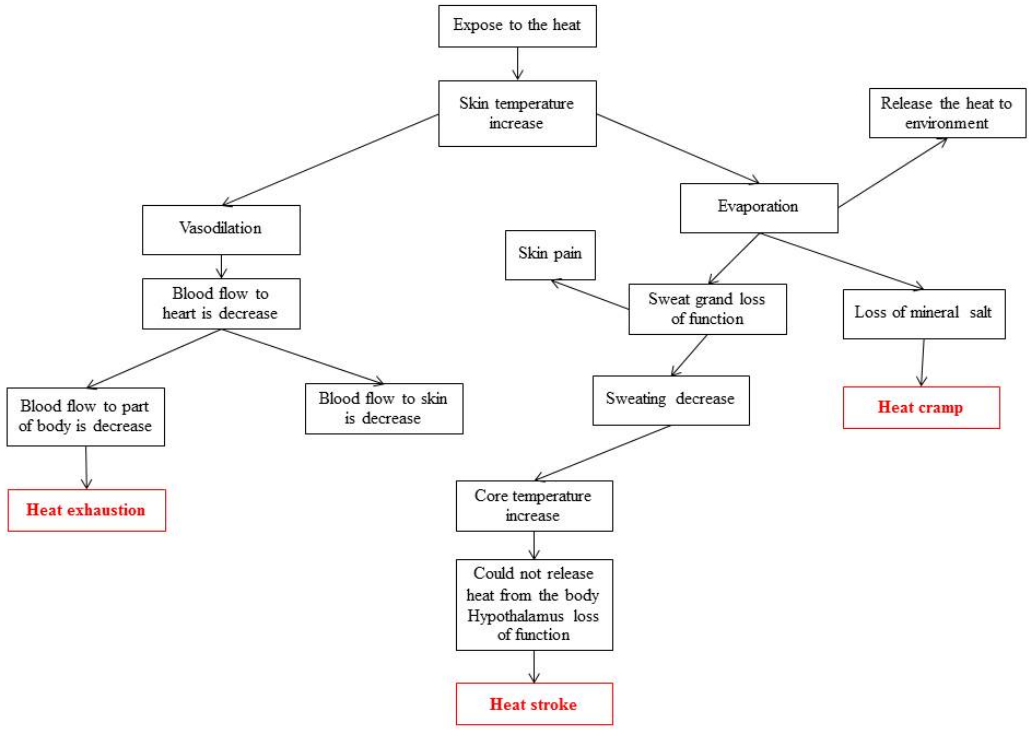


Figure 4.14 Heat-related illness [11]

Disease contributed by heat and preventive action

1. Heat stroke: Hot and dried in red or blue skin with 40.5 ºC or higher core temperature. Confused and cramped with being unconscious may also be occurred. Lately medical treatment given may cause fatality.

Causes: Abnormal sweating or could not release the heat from the body.

Treatment: Cover the body with wet substance and blow with cooled air then transfer the patient to the hospital.

Prevention: Screen only healthy employee to work in hot area and prepare them with acclimatization program.

2. Heat syncope: Faint, dizzy and being unconscious while standing in hot area.

Causes: Expanded blood vessel caused lowered blood in the lower part of the body.

Treatment: Prostrate the patient at cooled place and give them hydration.

Prevention: Screen only healthy employee to work in hot area and prepare them with acclimatization program.

3. Heat exhaustion: Fatigued, dizzy, being nauseated, light heartbeat, low blood pressure, dehydrated, low urination with high body temperature up to 38.5 ºC.

Causes: Dehydrated, unwell blood circulation.

Treatment: Prostrate the patient at cooled place and give them hydration.

Prevention: Prepare the employee with acclimatization program and provide mineral and sufficient drinking water.

4. Heat cramp: Muscle twitching causes much pain. Mostly occurred to arm, leg and stomach muscle, both while working and after working when touching with cooled water.

Causes: Too much mineral lost cause unbalanced mineral in the body.

Treatment: Give electrolyte beverage to the patient and rest them in cooled place with muscle massage.

Prevention: Provide proper mineral intake to be balanced with losses.

5. Heat rash : Irritate red pimple in large area.

Causes : Clogged and inflamed perspiratory gland.

Treatment : Clean the skin to avoid infection and heat reduction.

Prevention : Keep the skin dried and cleaned.

Heat prevention guideline.

1. Preventing at the source i.e., eliminate the source of heat or using alternative energy like doing process modification or substation of energy source.

2. Preventing at the path of heat, engineering control i.e., adjust the equipment materials, installing air ventilation system and using of heat shield.

3. Preventing by principle of its management i.e., schedule to work in hot environment session in the early morning or late afternoon to avoid heat from sunlight. Setting appropriate working hours and resting hours, provide sufficient drinking water and electrolyte beverage and acclimatization program.

4. Personal preventing by using PPEs i.e., radiation-resist suit, heat-resist suit or glove.

Emergency protocol in case of heat stroke

In case of heat stroke suspicious, should take these steps:

1. Immediately transfer the patient into airy-cooled place.

2. Remove the person's unnecessary clothing, and place the person on his or her side to expose as much skin surface to the air as possible.

3. Cover the patient’s body with wet material then blow with cooled air.

4. Transfer the patient to the hospital.

Acclimatization Program

This program prepares the employees to be used to in hot environment in their working area for new employee or the one who is rotated to the other area more than 2 weeks and needs to get back to this area again.

Table 4.11 Acclimatization program

	Day1	Day2	Day3	Day4	Day5
Working hours	50%	60%	70%	80%	90%
Resting hours	50%	40%	30%	20%	10
Engineer/ shift supervisor signature					

Work Instruction
of
Working Hour of Work Related to Heat

Scope

This work instruction is used as standard of prescribing working hours and resting hours of work in related to heat for employee who works at drying process.

Working Steps

1. Safety officer in professional level evaluates work condition and specify works at drying process as moderate work load.

2. Production engineer, safety officer in supervising level and professional level study working hours of the employees and create standard working hours and resting hours.

3. Safety officer in professional level re-evaluates working hours and resting hours by using heat monitoring principle e.g. heart rate, body temperature and body weight.

4. After appropriate working and resting hours are obtained, review in every year.

Related Documents

1. Appropriate working and resting hours table.

Table 4.12 Appropriate working and resting hours table

Thickness (mm.)	Sheet weight (kgs)	Sheets/ car	Car pushing time (mins)	Resting hours	Cars/ shift
8	40	30	24	Rest 10 mins in every 2 cars loaded	20
11	55	30	24		20
14	70	26	26		16
16	80	26	26		16
20	100	20	34	Rest 10 mins in every a car loaded	14
22	110	20	34		14
25	125	18	40		12
30	148	18	40		12

Work Instruction
of
Health Monitoring of the Employee Working at Drying Process

Scope

This work instruction of health monitoring of the employee who works at drying process is used for monitor harms and disease from heat.

Working Steps

1. Human resources department provides the water cooler for 2 spots at dryer entrance and exit places.

2. Production engineer provides electrolyte beverage to employee especially in March and April.

3. Production engineer and shift supervisor check readiness of the employee everyday by observing and preparing readiness to work e.g. doing light exercise in safety minute session.

4. Production engineer and shift supervisor have to control the employee to work up to appropriate specified standard of working and resting hours table while they are working.

5. After end of shift work, production engineer and shift supervisor observe abnormal issue which might occurred to the employee. In case of abnormal found, investigation with safety officer in professional level should take place.

6. Production engineer check equipment and tools related to work i.e., air ventilation system and heat insulation to ensure to always efficiently work.

7. Safety officer in professional level reviews incidents and illnesses data occurring at drying process and analyzes to create the tendency with reporting to plant manager no. 1 once a month.

8. Safety officer in professional level and human resources department provides health checkup by risk factors as detailed below.

8.1 Health checkup by risk factors before hiring should be done within 30 days since start hiring the employee.

8.2 Annually health checkup by risk factors.

8.3 Health checkup by risk factors once rotation occurred should be done within 30 days after rotation.

8.4 Health checkup by risk factors after employee get recovered from pains or illnesses and will be back to work by medical doctor's decision.

9. Health checkup results should be informed to the employee within 7 days and 3 days for normal result and abnormal result, respectively, after receiving the report.

10. In case of abnormal result found, causes finding, medical treatments with corrective and preventive actions should be done and report to the director-general within 30 days.

Related Documents

1. Incidents and illnesses report from the infirmary.
2. Health checkup with abnormal and illnesses report.

Work instruction
of
Heat at Drying Process Evaluation

Scope

This work instruction of heat at drying process evaluation is used as a standard for evaluation and analysis of heat level in working environment.

Working Steps

1. Safety officer in professional level specify light, moderate and heavy work load by evaluation of input energy of employee to that work or calculate along the OSHA technical manual. For this case, works at drying process is classified as moderate work load.

2. In April of every year, the safety officer in professional level has to monitor and analyze heat level in drying process area by:

2.1 Contact the registered organization to do monitoring and analyzing the working condition exposed to heat or

2.2 Self-monitoring by using equipment from SCCC.

3. The equipment must be able to show and calculate the WBGT index that meets the ISO 7243 and has to be calibrated before using.

4. Measure the WBGT at 4 heat area samples; 2 samples at dryer inlet and others at dryer outlet.

5. Install the measuring device at chest-height level of the employee who works at drying process. Using the average value of 2 hours at the hottest of the day.

6. Safety officer in professional level analyzes the result and compares between work load and temperature.

7. Then proceed the following steps:

7.1 If the analysis found that the temperature is conform to work load, sign for acknowledging and propose to production engineer, manager of

plant no.1 as well as Vice President production and quality management and report to the director-general onwards

7.2 If the analysis found that the temperature is not conform with work load, report to production engineer, plant no.1 manager as well as Vice President production and quality management to find the causes and specify corrective and preventive before report to the director-general.

Related Documents

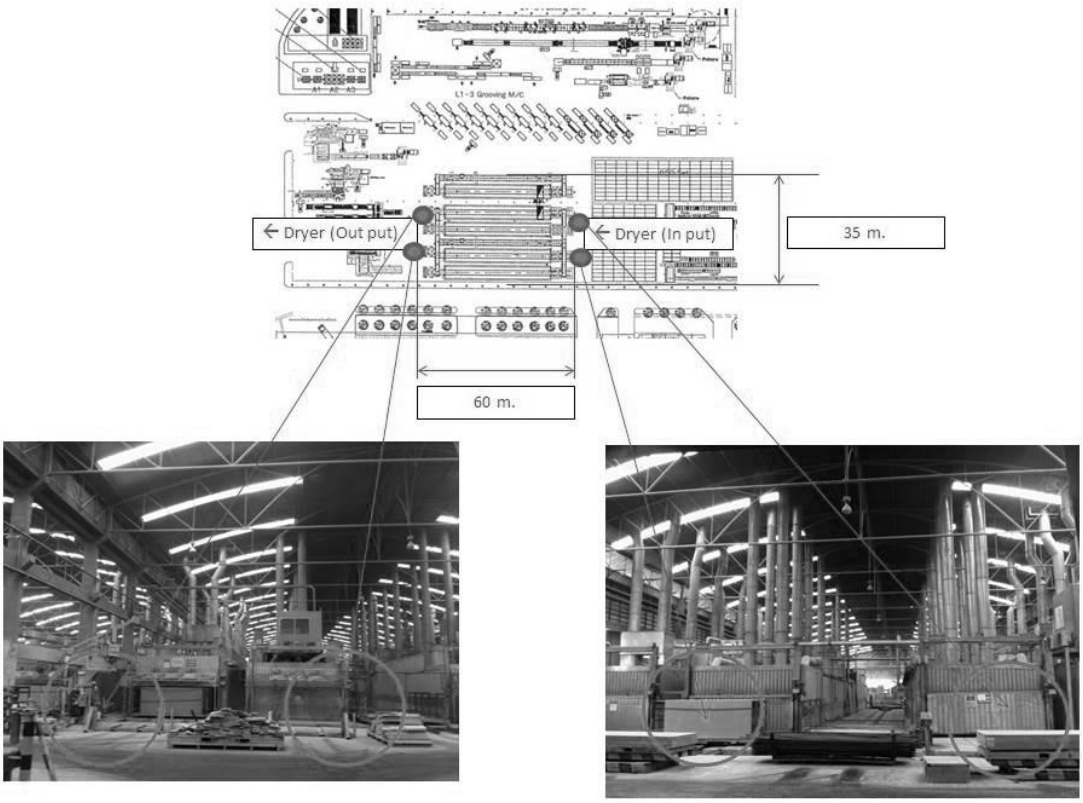


Figure 4.15 Layout of heat monitoring at drying process.

Work instruction
of
Personal Protective Equipment (PPE)

Scope

This work instruction of personal protective equipment is used to enforce employees and contractors who work in drying process area.

Working Steps

1. Safety officer in professional level set the specification of PPE and create table of necessary PPE type in drying process area.

2. Safety officer in professional level provides training session of how to properly use PPE to the employee who works at drying process.

3. Production engineer and shift supervisor provide PPE as supervised by safety professional to the employee and ensure that every employee is always use PPE. The PPE supply has to be done systematically.

4. If production engineer or shift supervisor found any employee without PPE put on, command to immediately stop working until properly PPE is already put on.

5. The employee at drying process is always wearing PPE as provide by engineer or shift supervisor.

Related Documents

1. Table of standard and PPE require employee at drying process to always wear PPE.

Table 4.13 Standards of PPEs for employees at drying process.

No.	PPEs	Standards	Useful life
1	White or yellow safety helmet with inside 6 points support and chin strap	TIS 368-2554 or equivalent	3-5 years
2	Earplug	TIS 2575 Book1 -2555	7 -14 days
3	Uniform (Made from cotton)	-	As seen
4	Plastic glove/ Nitrile glove	-	As seen
5	Safety shoes	TIS 523-2554 or equivalent	1 year

Work instruction
of
Warning Signs and Symbols Related to Heat at Drying Process

Scope

This work instruction of warning signs and symbols related to heat at drying process is created to set standard of warning signs and symbols related to heat.

Working Steps

Production engineer is prescribed to provide these warning signs and post them in drying process area.

1. At dryer inlet and outlet.

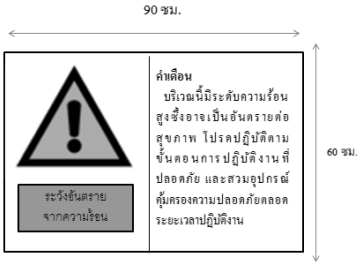


Figure 4.16 Warning sign at dryer inlet and outlet.

2. At surfaces of material, equipment with higher than 60 ºC and there is opportunity to be touched by the employee at drying process.

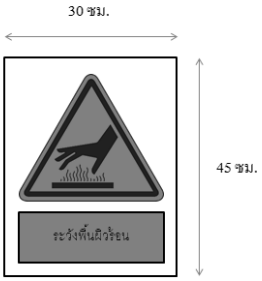


Figure 4.17 Warning sign at surfaces of material, equipment with higher than 60 ºC

CHAPTER V
DISCUSSION

The management guideline for heat exposure at drying process was created along this study, which the results of this study are shown below.

5.1 Reviewing of current heat management consists of these topics as following.

5.1.1 Evaluation of requirements and regulations conforming. It was found that there were some aspects that non-conformed i.e., harms from heat were excluded in risks assessment, manuals and work instructions did not exist that caused lacking of training session related to heat exposure prevention. Due to the fact that company did not well understanding in details of the requirements and regulations.

5.1.2 Evaluation of working condition at drying process.

5.1.2.1 It was found that there were inappropriate building structure and air ventilation system. At the end of the building structure equipped with insufficient ventilation fans.

5.1.2.2 The main heat sources were including of heat from dryer which heat and hot steam were released once the dryer doors opened as well as the heat from dried board.

5.1.2.3 The employee was stationed at the same position almost all the time of working, so spot cooling system was therefore recommended

5.1.3 Reviewing results of the incidents in 2 years back showed that there were total 9 incidents, 5 incidents. These might cause by too high heat level in working area.

5.1.4 Reviewing results of status of employee who works at drying process showed that there were 9 healthy male and 1 female employees who have more than 2 years of services and suitable to work at drying process. However, an employee had chronic disease, high blood pressure which should be assigned to another appropriate work.

5.2 Evaluation of working hours and resting hours by using health monitoring program.

5.2.1 Monitoring of heart rate at resting state after stop working for 30 minutes. The results showed normal heart rate in 9 of 10 employees and slightly higher than level of standard specified in the rest of employee. So the working hours was considered as appropriate.

5.2.2 Evaluation of heart recovery rate by the recommendation of OSHA technical manual found the results of heart rate of the employee after stop working, measured after 30 seconds and 2.5 minutes rested, respectively. Good heart recovery rate should be differed more than 10 beats/mins but as of the results, there were not much different between 30 seconds and 2.5 minutes. However, it did not mean that the employees did not have good heart recovery rate. The heart rate at resting state comparing to 30 seconds rest was also not much different as well. This could be implied as there were no fatigues among the employees or there was sufficient and proper resting provided.

5.2.3 Evaluation results of employee's body temperature after end of shift work showed that 9 of 10 employees were in normal temperature range. There was only 1 person which accounted for 0.1 ºC higher than standard required of body temperature.

5.2.4 Evaluation of dehydration by body weighting, the results showed that the weight of 2 of 10 employees was reduced more than 1.5% in a working day, it might cause by high heat exposure.

5.3 Create management guidelines for heat exposure at drying process.

The management guidelines for heat exposure at drying process was created covering the procedures of working at heat area or related. The conformity evaluation results were also used to set working steps. These guidelines would support the company to be completely aligned with regulations conformity.

CHAPTER VI
CONCLUSION

The study results were summarized for creating guideline for heat at drying process management with comparing to the specified objectives as following.

Summarized by general objectives

6.1. To evaluate related requirements and regulations conformity.

The conformity of requirements and regulations in relation to work in area related to heat was evaluated. It was found that there were some aspects which were not conformed to the occupational safety, health and environment act B.E. 2554 as detailed below.

Section 14 Prescribes the role of the employer to inform the employee regarding conditions of work in risks and provide work instructions. The company had warning and training procedures but no work instructions provided.

Section 16 Prescribes the role of the employer to provide training course regarding occupational safety, health and environment to all employees. The company did not provide training course titled specific to working in area related to heat.

Section 32 Prescribes the role of the employer to evaluate harms. The company already done the evaluation but working in area related to heat topic was not included.

Besides, it also found the non-conformity with the ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment B.E. 2549. In clause 3, prescribes the role of the employer to provide the rules and safety manual to ensure safely working and enforce

to all employees to follow. The company had the rules and safety manual which was not cover to harm from heat, also including clause 5 mentioning about the new employees in area.

For other conformities in related regulations i.e., the ministerial regulation on the prescribing of standard for administration and management of occupational safety, health and environment in relation to heat, light and noise B.E. 2549, the rule of the department of labour protection and welfare on the prescribing of criteria, method and work condition analysis in relation to heat, light and noise B.E. 2550, the ministerial regulation on the prescribing of criteria and method of conducting health checkup of employees and forwarding the results of health checkup to labour inspector B.E. 2547 and the rule of the Department of Labour Protection and Welfare on Prescribing of Personal Health Checkup Form of Employee Who Work with Risk Factors and Abnormal Results Reporting, Illness, Medical Treatments Form and Preventive Actions B.E. 2551 (A.D. 2008), they were all conformed following.

6.2 To evaluate harms from heat and conduct employee's health monitoring.

Harms were evaluated by studying factors contributed to heat in work environment affecting employees, as described below.

6.2.1 Propose the appropriate air ventilation system is spot cooling system

6.2.2 There were 9 incidents in 2 years back period. It was not clear that they were caused by heat but heat cramp was higher tendency to occur in hot area due to summer season.

6.2.3 Investigate working and resting hours by using a health monitoring program of OSHA Technical manual. Heart rate, body temperature and body weight of the employees were measured before and after shift work. The results showed that the working and resting hours were conducted appropriately. There were not too much fatigue caused by heat exposure of employees in drying process area.

Summarized by specific objectives

6.3 To create the guideline for heat at drying process management.

The guideline for heat at drying process management was created by collecting data from this study. There are 6 work instructions and 7 topics of related documents and templates mentioning in this guideline. It would be used as the guideline for heat at drying management conforming to the requirements and regulations as well as covering to diseases from work related to heat in working environment.

Suggestions

1. Due to this study was not conducted in the hottest month of the year; the results might be different. The evaluation and reviewing should be done by following the specified method in work instructions in the hottest month of the year again.

2. This study was carried on only population and day-time working environment. It might be varied in the night due to any other different factors. The investigation might be conducted again in the night for next study.

3. The collected incident data was not applicable to be indicated as working in area related to heat results; should more investigate on this matter in next study.

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3. กฎกระทรวง กำหนดมาตรฐานในการบริหารและจัดการด้านความปลอดภัย อาชีวอนามัย และสภาพแวดล้อมในการเกี่ยวกับความร้อน แสงสว่าง และเสียง พ.ศ. 2549. ราชกิจจานุเบกษา เล่ม 123 ตอนที่ 23 ก (ลงวันที่ 6 มีนาคม 2549)
4. กฎกระทรวง กำหนดมาตรฐานในการบริหารและการจัดการด้านความปลอดภัย อาชีวอนามยั และสภาพแวดล้อมในการทำงานเกี่ยวกับความร้อน แสงสว่าง และเสียง พ.ศ. 2549. ราชกิจจานุเบกษา เล่ม 123 ตอนที่ 23 ก (ลงวันที่ 6 มีนาคม 2549)
5. ประกาศกรมสวัสดิการและคุ้มครองแรงงาน เรื่อง หลักเกณฑ์ วิธีดำเนินการตรวจวัด และวิเคราะห์สภาวะการทำงานเกี่ยวกับระดับความร้อน แสงสว่าง หรือเสียงภายในสถานประกอบกิจการ ระยะเวลา และประเภทกิจการที่ต้องดำเนินการ พ.ศ. 2550. ราชกิจจานุเบกษา เล่ม 125 ตอนพิเศษ 76 ง (ลงวันที่ 22 มิถุนายน 2550)
6. กฎกระทรวง กำหนดหลักเกณฑ์และวิธีการตรวจสุขภาพของลูกจ้าง และส่งผลการตรวจแก่พนักงานตรวจแรงงาน พ.ศ. 2547. ราชกิจจานุเบกษา เล่ม 122 ตอนที่ 4ก (ลงวันที่ 13 มกราคม 2548)
7. ประกาศกรมสวัสดิการและคุ้ มครองแรงงาน เรื่อง กำหนดแบบสมุดสุขภาพประจำตัวของลูกจ้างที่ทำงานเกี่ยวกับปัจจัยเสี่ยง และแบบแจ้งผลการตรวจสุขภาพของลูกจ้างที่พบความผิดปกติหรือการเจ็บป่วย การให้การรักษาพยาบาล และการป้องกันแก้ไข พ.ศ. 2551. ราชกิจจานุเบกษา เล่ม 125 ตอนพิเศษ 30ง (ลงวันที่ 11 กุมภาพันธ์ 2551)
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APPENDICES

APPENDIX A
ETHICAL APPROVAL DOCUMENT

Certificate of Approval
Ethical Review Committee for Human Research
Faculty of Public Health, Mahidol University

COA. No. MUPH 2015-181

Protocol Title :	GUIDELINE FOR HEAT MANAGEMENT OF DRYING PROCESS IN FIBER-CEMENT MANUFACTURING
Protocol No. :	160/2558
Principal Investigator :	Mr. Thavorn Tansatiean
Affiliation :	Master of Science Program in Occupational Health and Safety Faculty of Public Health, Mahidol University
Approval Includes :	1. Project proposal 2. Information sheet 3. Informed consent form 4. Data collection form/Program or Activity plan
Date of Approval :	18 November 2015
Date of Expiration :	17 November 2016

The aforementioned project have been reviewed and approved according to the Declaration of Helsinki by Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University.

(Assoc. Prof. Dr. Sutham Nanthamongkolchai)
Chairman of Ethical Review Committee for Human Research

(Assoc. Prof. Dr. Prayoon Fongsatitkul)
Dean of Faculty of Public Health

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Figure A-1 COA

ส่วนที่ 1 คำถามทั่วไป

1. เพศ ☐ ชาย ☐ หญิง
2. อายุ ☐ 18 -25 ปี ☐ 26-30 ปี ☐ 31-35 ปี ☐ 36-40 ปี ☐ 41 ปีขึ้นไป
3. น้ำหนัก / ส่วนสูง ..... BMI .....
4. ความดันโลหิตขณะพัก ..... mmHg
5. โรคประจำตัว ☐ ไม่มี ☐ มี ระบุ.....
6. อายุงานที่แผนกอบแห้ง

   ☐ น้อยกว่า 6 เดือน ☐ 6 เดือน - 1 ปี ☐ 1 – 2 ปี ☐ 2 ปีขึ้นไป
7. การเจ็บป่วย / ไม่สบายจากการทำงาน ในช่วง 2 ปี ที่ผ่านมา

   ☐ ไม่มี ☐ มี ระบุโรค.....

   ครั้งล่าสุดที่เจ็บป่วย / ไม่สบายจากการทำงาน ประมาณ..... เดือน
8. อุบัติเหตุจากการทำงานในช่วง 2 ปี ที่ผ่านมา ☐ มี ☐ ไม่มี
9. การเข้ารับการอบรมเรื่องอันตรายจากความร้อน ☐ เคย ☐ ไม่เคย
10. การเข้าโปรแกรมปรับสภาพร่างกายให้ชินกับวามร้อน ☐ เคย ☐ ไม่เคย

ส่วนที่ 2 ข้อมูลการเก็บตัวอย่างในขณะทำงาน ใช้เฝ้าระวังอันตรายจากความร้อน

1. อัตราการเต้นของหัวใจ วัดหลังจากหยุดปฏิบัติงานในรอบระยะเวลาการทำงาน และหยุดพัก 30 วินาที

   อัตราการเต้นของหัวใจที่วัดได้ ..... ครั้ง / นาที
2. อัตราการการเต้นของหัวใจระยะพักฟื้น

   อัตราการเต้นของหัวใจหลังจากหยุดปฏิบัติงานในรอบระยะเวลาการทำงาน และหยุดพัก 30 วินาที (P1)

   อัตราการเต้นของหัวใจหลังจากหยุดปฏิบัติงานในรอบระยะเวลาการทำงาน และหยุดพัก 2.5 นาที (P3)

   P1 = ... ครั้ง/นาที , P3 = ...ครั้ง/นาที , P1-P3 =..... ครั้ง/นาที
3. น้ำหนักชั่งตอนเช้าก่อนเริ่มงาน..... กิโลกรัม น้ำหนักหลังเลิกงาน..... กิโลกรัม
4. อุภณหภูมิหลังเลิกปฏิบัติงาน วัดทันทีก่อนผู้ปฏิบัติงานดื่มน้ำ..... องศาเซลเซียส

Data collection form Version 15 November 2015

Figure A-2 Questionnaire

APPENDIX B
SAMPLING DEVICES

Figure B-1 Blood pressure and heart rate checking device

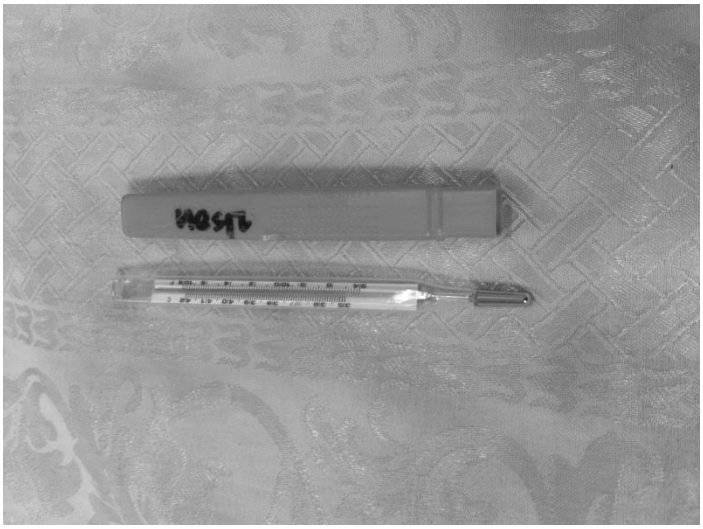

Figure B-2 Body temperature checking device

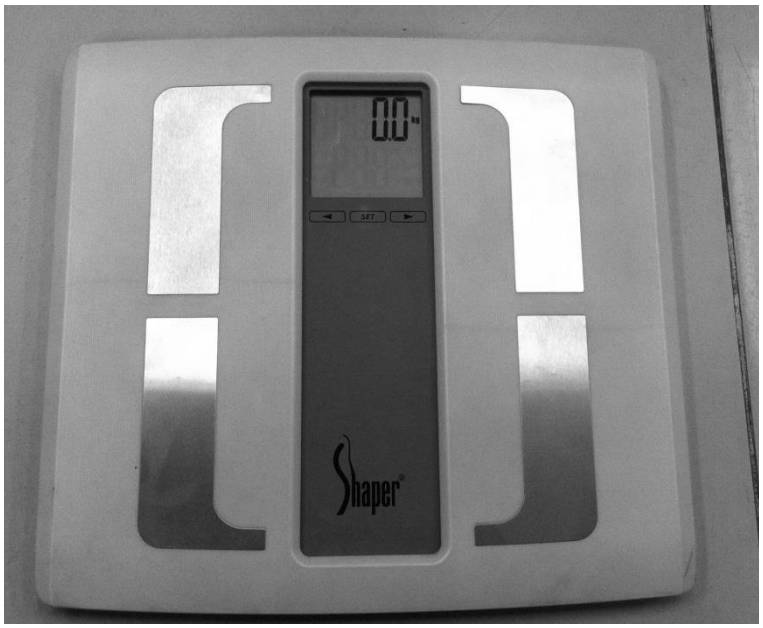

Figure B-3 Body weight checking device

APPENDIX C
EMPLOYEES SAMPLING

Figure C-1 checking of heart rate, body temperature and body weight

BIOGRAPHY

NAME	Thavorn Tansatiean
DATE OF BIRTH	26 June 1984
PLACE OF BIRTH	Bangkok
INTITUTIONS ATTENDED	Burapha University, 2004-2007 Bachelor of Science (Industrial Hygiene and Safety) Mahidol University, 2013-2016 Master of Science (Occupational Health and Safety)