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DEPARTMENT OF INDUSTRIAL WORKS

ENVIRONMENTAL MANAGEMENT FRAMEWORK



HCFC PHASE-OUT PROJECT

POLYURETHANE FOAM SECTOR – STAGE 1

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List of Abbreviations

ASME	American Society of Mechanical Engineers
CAS No	Chemical Abstract System Number
CEC	Canadian Electric Code
CFC	Chlorofluorocarbon
CO ₂	Carbondioxide
CP	Cyclo-pentane
dB	Decibel
DIW	The Department of Industrial Works
EC	European Country
EHS	Environmental, Health and Safety
EMF	Environmental Management Framework
EMP	Environmental Management Plan
Ex	Explosive / explosion
GHG	Greenhouse Gases
GHS	Global Harmonized System
GSB	Government Savings Bank
GWP	Global Warming Potential
HCFC	Hydro chlorofluorocarbon
HPMP	HCFC Phase-out Management Plan
IEC	International Electrical Code
LEL	Lower Explosive Limit
MDI	Methyl Diisocyanate
MLF	Multilateral Fund
MOI	The Ministry of Industry
MSDS	Material Safety Data Sheet
MT	Metric Tons
NEC	National Electric Code
NFPA	National Fire Protection Association
NOU	The National Ozone Unit
ODS	Ozone-Depleting Substance
OHS	Occupational Health and Safety
PLC	Programmable Logic Controller
PMU	Project Management Unit
PU	Polyurethane
SME	Small and Medium-size Enterprises
TISI	Thai Industrial Standard Institute
SIC Number	Standard Industrial Classification Number
SOP	Standard Operating Procedures

1. Introduction

The Government of Thailand has requested the World Bank to assist Thailand with the implementation of the HCFC Phase-Out Plan for the foam sector, which is part of the overall HCFC Phase-Out Management Plan (HPMP) Stage I. The implementation of the HPMP is supported by a grant from the Multilateral Fund to assist Thailand in meeting its obligations under the Montreal Protocol. The implementation of the HPMP is led by World Bank. The objective of foam sector plan under HPMP Stage I is to phase-out the consumption of HCFC-141b in foam blowing in all polyurethane (PU) foam applications, except spray foam application by January 1, 2016. This would contribute to Thailand's targets of meeting HCFC consumption freeze at the baseline level (average consumption between 2009 and 2010) in 2013, 10% reduction in 2015 and 15% reduction in 2018. To support of the phase-out, the Government of Thailand has already introduced a quota system for the import of HCFCs.

The project involves investments for the conversion of the foam blowing technology in approximately 190 enterprises from HCFC to suitable blowing alternatives, in particular hydrocarbons (Cyclopentane), HFC-245fa and water blown technologies. There are varieties of foam application in Thailand as follows;

- Box Foam
- Commercial Refrigeration (foam component)
- Steel/Fiberglass door
- Ice Box
- Pipe Section/Pipe-in-pipe Insulation
- Pipe Section and Sandwich Panel
- Refrigerated Truck, Reefer, Fishery vessel
- Sandwich Panel
- Spray Foam
- Thermoware
- Wood Imitation
- Flexible molded foam
- Integral skin foam

Each type of applications listed above varies in term of business scale such as small-family business; medium enterprise with simple tools and equipment used in foam injection process; and large scale manufacturing that have well-designed of equipment and tools to handle foam injection process.

Implementation of these technologies will be carried out in compliance with applicable laws, policies and environmental best practices as described in this Environmental Management Framework (EMF). The Environmental Management Framework (EMF) contains a series of mitigation and enhancement measures designed to ensure that the project minimizes any possible negative impacts and bring about positive results.

2. Objectives

The HCFC Phase-out Project is assigned as an Environment Category B Project and triggers the World Bank's Operational Policy (OP)/Bank Procedure (BP) 4.01 - Environmental Assessment (EA). Since not all the foam beneficiaries have been identified by appraisal, an EMF has been prepared to provide guidance to all stakeholders including the DIW and beneficiary enterprises to effectively identify and address environmental safeguard issues that may arise from the proposed sub-project investment. The EMF also includes a template of the Environmental Management Plan (EMP). Beneficiary enterprises will use the EMF and template of EMP to prepare their own EMP that environmental safeguard issues are properly addressed during the conversion to alternative technology.

The EMF has been prepared and publicly disclosed in line with the World Bank's Operational Policy (OP)/Bank Procedure (BP) 4.01 - Environmental Assessment (EA) and in accordance with Thai National Laws and Regulations. To the extent relevant, the applicable World Bank Group Environmental Health and Safety Guidelines have been taken into consideration in preparing the EMF and EMPs.

The objectives of this EMF are to:

- (a) Identification of potential risk associated with the foam technology alternatives selected by the participating companies (sub-projects) compared to their baseline situation,
- (b) Provide information on safety and environmental requirements and capacities needed for the introduction of alternative foam blowing technologies in participating companies.
- (c) Describe procedures and methodologies for proper handling of alternative foam blowing technologies and installation of related equipment, in particular protective equipment and safety measures for the use of hydrocarbons in compliance with applicable national regulations and international standards.
- (d) Provide guidance for the preparation of an Environmental Management Plan (EMP) for enterprises converting to hydrocarbon technology.
- (e) Describe equivalent mitigation measures in Standard Operating Procedures (SOP) for companies converting to HFC-245fa technology and water blown technology.
- (f) Specify roles and responsibilities, and outline the necessary reporting and approval procedures, for the management and monitoring of environmental impacts related to the conversion activities and the use of the alternative technologies in each participating company.

3. Background of PU Foam Sector in Thailand

3.1 Overview of Polyurethane Foam

Polyurethane is a compound called reaction polymers. It is produced by reacting Isocyanate with Polyol in the presence of a catalyst. One of the most desirable attributes of polyurethanes is their ability to be turned into foam. Producing foam requires the formation of a gas at the same time as the urethane polymerization is occurring. The gas can be carbon dioxide, either generated by reacting Isocyanate with water. (The water blown technology uses this simple principle to make foam.) or added as a gas or produced by boiling volatile liquids which is so called a blowing agent. Polymerization reaction is exothermic; heat generated causes the blowing agent to vaporize.

Hydrochlorofluorocarbons (HCFCs) are chemical substances used primarily as refrigerants in refrigeration and air-conditioning equipment and as blowing agents for producing polyurethane foam. Blowing agents are key components of a polyurethane formulation; they are needed to obtain the foam structure, the important role of blowing agent is, especially for rigid foams, affecting important properties such as thermal insulation, density and mechanical strength. Montreal Protocol, which requires the reduction of substances depleting the ozone layer, and represents one of the most successful international cooperation to tackle a major global environmental threat. HCFCs were introduced as transitional substances to replace the wide use of chlorofluorocarbons (CFCs) that were phased out globally as of January 1, 2010 in accordance with the Montreal Protocol on Substances that Deplete the Ozone Layer. Although significantly less potent than CFCs, HCFCs are also ozone-depleting substances (ODS) as seen in the Table 3-1, and are consequently controlled by the Montreal Protocol and will be phased-out in accordance with the provision of the Montreal Protocol. In addition, HCFCs are greenhouse gases (GHG) with a global warming potential (GWP) ranging from several hundred to several thousand times of CO₂.

The alternative foam blowing technology such as HFC-245fa has zero Ozone Depletion Potential while its Global Warming Potential is considerably higher than hydrocarbon technology. To convert to zero ozone depletion potential blowing agent while minimizing greenhouse effects, Cyclo-pentane provides more advantage than HFC-245fa because it is non-ODS and negligible GWP blowing agent. However, low flash point and flammability is the key concerns when converting to Cyclo-pentane technology.

Table 3-1 Zero ODP and Zero ODP/Low GWP Blowing agents

Compound	Flash Point (°C)	ODP	GWP
CFC-11	None	1	4750
HCFC-141b	None	0.11	725
HFC-134a	None	0	1300
HFC-245fa	None	0	1050
HFC-365mfc	- 24	0	840
n-Pentane	- 49	0	11
Iso-Pentane	- 51	0	11
Cyclo-pentane	- 37	0	11
CO ₂	None	0	1.0

3.2 PU Foam Sector in Thailand

The PU foam sector in Thailand is categorized into rigid polyurethane, flexible polyurethane foam and integral skin foam sub-sector and comprises large, medium and smaller-sized enterprises. Moreover, the PU foam sector also includes seven system houses; and thirteen Polyol suppliers (7 of which are the same system houses) which provide HCFC-based Polyol to the Thai market. Polyol is imported into Thailand as base Polyol and blended by the system houses in their own facilities.

There are 215 PU foam enterprises that still use HCFC-141b as foam blowing agent in Thailand. HPMP Stage I project will consider 185 enterprises with PU foam application, except 30 enterprises that use the spray foam application, which will be address in the subsequently stage of HPMP due to the lack of suitable replacement technology. Currently, the major multinational firms that produce domestic refrigerator panels and larger locally-owned enterprises, particularly the manufacturers of sandwich panels, have similarly all changed over the foam blowing agent to Cyclo-pentane while increasing their output on their own. PU foam enterprises under HPMP Stage I that are currently consuming HCFC-141b are classified as small and medium-size enterprises (SMEs) – i.e. foam companies with annual consumption of HCFC-141b less than 50 MT (medium) and less than 20 MT (small) and micro enterprises – i.e. foam companies with annual consumption of less than 1 MT of HCFC-141b.

Most HCFC-141b consuming enterprises are in rigid foam sector. There are a few flexible polyurethane foam and integral skin foam companies that still use HCFC-141b as blowing agent because most foam enterprises manufacturing flexible foam and integral skin foam have converted from CFCs directly to water-blown technologies or methylene chloride and do not use HCFCs. Table 3-2 shows the breakdown of number of foam enterprises and respective HCFC-141b consumption by applications.

Table 3- 2: Distribution of HCFC-141b Use in Thailand's Foam Sector

Sector/Application	No. of Enterprises	HCFC-141b Consumption			
		2007 (MT)	2008 (MT)	2009 (MT)	2010 (MT)
Rigid Polyurethane					
Box Foam	4	44.7	61.4	70.2	60.1
Commercial Refrigeration (foam component)	14	110.4	136.6	132.8	147.5
Steel/Fiberglass door	6	29.0	32.6	32.5	28.5
Ice Box	44	592.3	604.4	634.1	602.8
Pipe Section/Pipe-in-pipe Insulation	6	41.3	39.3	50.4	62.7
Pipe Section and Sandwich Panel	3	32.8	38.3	40.6	38.4
Refrigerated Truck, Reefer, Fishery vessel	13	43.2	59.3	59.7	70.3
Sandwich Panel	25	242.7	275.4	246.9	332.2
<i>Spray Foam (Not in HPMP Stage I)</i>	30	295.9	330.1	298.6	349.1
Thermoware	7	46.6	54.5	47.9	45.7
Wood Imitation	6	27.6	32.2	39.2	49.0
Others	44	41.8	58.4	66.2	48.0
Sub-total Rigid Polyurethane Foam	202	1,548.2	1,722.6	1,719.1	1,834.4
Flexible Polyurethane	5	21.6	25.0	27.9	25.1
Integral Skin	8	19.3	28.0	24.3	24.1
Total Foam Sector	215	1,589.1	1,775.6	1,771.3	1,883.6

4. Project Description

4.1 HCFC Phase-out Project

The Project Objective is to reduce HCFC consumption in the air-conditioning and foam sectors in order to contribute to Thailand's efforts to meet its HCFC consumption phase-out obligations under the first phase of the program (2014-2018).

HPMP Stage I will assist 12 manufacturers of air-conditioner with major Thai ownership and approximately 185 foam enterprises to phase-out HCFCs by converting to alternative technology. HPMP Stage I will also include technical assistance activities to support HCFC phase-out activities and project management to strengthen operation capacity of the Department of Industrial Works (DIW) and the Government Savings Bank (GSB). Moreover, Thailand has received grant funds for the implementation of the Institutional Strengthening (IS) Project, which aims to strengthen operation capacity of the National Ozone Unit (NOU) of DIW to ensure country's compliances under the Montreal Protocol. Both HPMP Stage I and IS project are under the umbrella of the HCFC Phase-out Project (the Project), which categorizes activities into 4 Components. Components 1, 2 and 3 of the Project are those related to implementation of the HPMP Stage I, while Component 4 of the Project is for the IS project as follows:

- **Component 1 - Investment in HCFC Consumption Reductions:** The Project will provide financial support to eligible 12 air-conditioner and approximately 132 small and medium foam manufacturing enterprises to convert to non-ODS and low/lower GWP alternatives. Component 1 also includes financial support to a Thai-owned manufacturer of compressor to develop non-ODS compressor in air-conditioning and commercial refrigeration sector and to eligible foam system house to conduct an in-house test of new non-HCFC-141b foam systems.
- **Component 2 - Technical Assistance:** The Project will provide technical assistance to related stakeholders to support HCFC-141b and HCFC-22 phase-out. This Component includes technical assistance to micro enterprises on the use of non-HCFC-141b formulations, technical assistance to 12 beneficiary enterprises for the conversion to HFC-32, activities to promote emerging low-GWP and non-ODS technology for large and small AC systems and development and provision of train-the-trainer programs on good servicing practices for HFC-32 air-conditioning units.
- **Component 3 – Project Management:** Financial support will be provided for technical assistance to improve the capacity of DIW and GSB to manage, supervise, monitor and report on activities under the HPMP Stage I, and to evaluate the implementation progress of the overall project towards the project development objectives and the terms and conditions of the agreement for the HCFC phase-out project between the Executive Committee and Thailand.
- **Component 4 – Strengthening of the National Ozone Unit:** Financial support will be provided for technical assistance to improve capacity of the NOU within DIW with regards to the management, supervision, coordination and evaluation of its HCFC import/export quota system, and to meet all the reporting requirements of the Montreal Protocol and its associated bodies.

DIW has been designated by the Ministry of Industry to serve as the national focal point and implementing agency for this project. DIW will be in charge of overseeing overall project implementation coordination particularly among government agencies and the industry. DIW will be responsible for providing technical input for engagement of consultants for technical assistance activities responsible by DIW including its PMU. DIW will manage grant funds for Component 4, some

technical assistance activities under Components 2 and those funds for the DIW's PMU under Component 3. GSB will be appointed to serve as an executing agency for Components 1, some technical assistance activities under Component 2 and those funds for the GSB's PMU under Component 3. DIW and GSB will be responsible for submission of financial reports and for appointing an external auditor as required by the Bank.

Enterprises will submit a sub-project proposal to GSB-PMU to request the grant funds for the conversion to GSB with a copy to DIW-PMU. DIW-PMU will determine the eligibility of the enterprises based on establishment date ensuring compliance with MLF criteria. In the meantime, GSB-PMU will review a sub-project proposal and supporting document, verify HCFC consumption to appraise and confirm the technical and financial feasibility of the proposals and recommend the appropriate level of funding. GSB will enter into sub-grant agreements with the beneficiary enterprises and will be responsible of monitoring implementation progress of sub-grant activities and reporting.

The Ministry of Finance (MOF) will enter into a US\$23.92 million grant agreement with the World Bank. The implementation of Thailand Stage I HPMP will start in early 2014 to ensure full compliance with phase-out obligations and desired project impacts attributed to interventions from the project. Upon receipt of grant proceeds, MOF, DIW and GSB will enter into subsidiary agreements, which describe their roles and responsibilities under the project.

4.2 PU Foam Sector Plan

Stage I of the HCFC phase-out (the Project) in the foam sector focuses on production of PU for all PU foam sector applications, except the spray foam. Private sector project participants include a tentative list of 185 foam enterprises all over Thailand consuming either HCFC-141b in bulk procured from importers or Polyol pre-blended with HCFC-141b supplied by Polyol system houses. This project supports a series of investment activities (mainly procurement of equipment) in the production facilities of these foam producers, related technical assistance to acquire technology transfer and training on the production of foam using alternative blowing agent, and import quotas for HCFC-141b. A project management unit (PMU) will be set up within the Department of Industrial Works of the Ministry of Industry, who will be responsible for the overall implementation of the project. Although the Project duration of HPMP Stage I is 5 years, it is expected that the investment sub-projects in foam sector will be completed by the end of 2015.

Although there are 215 foam enterprise still using HCFC-141b, 30 of which are enterprises in the spray foam application, which are not covered under HPMP Stage I. The production facilities of the 185 foam enterprises that have been identified as potential project participants under HPMP Stage I and covered under this EMF are mostly located in the Bangkok and Metropolitan area and nearby provinces. However, one foam company is not eligible for the MLF funding because of it is 100% owned by non-Article 5 ownership (funding from the MLF will be deducted according to the percentage of ownership from non-Article 5 parties or developed countries). Therefore, the beneficiaries in foam sector under HPMP Stage I would be 184 enterprises. Based on the HPMP Stage I, about 161 companies plan to adopt HFC-245fa and water as blowing agents, which require few modifications to their production process. The other 23 companies, that have sufficient HCFC-141b consumption and capacity to convert to hydrocarbon, plan to use Cyclo-pentane (a flammable substance) because of its negligible GWP, which is considered as long term alternative to HCFC-141b.

All the companies are located in commercial and industrial areas at safe distances from residential areas and will be able to implement the required safety measures within their existing facilities as discussed in the next section of this framework. Among 184 eligible foam enterprises under HPMP Stage I, 131 are small and medium enterprises that will implement the investment project as individual

sub-project to acquire equipment for alternative technology. However, the rest of these enterprises, 53 which are micro enterprises, will receive specific training on how to produce their products using alternative technology from the system house/Polyol suppliers.

Table 4-1 shows the summary of selection of alternatives by applications of the enterprises eligible under HPMP Stage I.

Table 4-1 Summary of Selection of Alternatives by Applications of Enterprises under HPMP Stage I.

Sector	Proposed Alternatives						Total	
	Cyclo-pentane		HFC-245fa		Water Blown		No. of Enterprises	HCFC-141b Consumption (MT)
	No. of Enterprises	HCFC-141b Consumption (MT)	No. of Enterprises	HCFC-141b Consumption (MT)	No. of Enterprises	HCFC-141b Consumption (MT)		
Small and Medium Enterprises								
Rigid Polyurethane								
Box Foam	4	60.12					4	60.12
Commercial Refrigeration	1	35.00	13	110.78			14	145.78
Steel / Fiber Glass Door			4	28.41			4	28.41
Ice Box	9	313.48	30	274.86			39	588.34
Pipe Section and Pipe-in-pipe Insulation			6	62.72			6	62.72
Pipe Section and Sandwich Panel	1	23.10	2	15.04			3	38.14
Refrigerated Truck, Reefer, Fishery Vessel			12	69.58			12	69.58
Sandwich Panel	8	207.93	13	113.89			21	321.82
Thermoware			7	44.13			7	44.13
Wood Imitation			3	48.96			3	48.96
Others			9	46.10			9	46.10
Sub-total	23	639.63	99	814.47			122	1,454.10
Flexible Polyurethane								
Integral Skin			4	16.49	4	25.05	4	25.05
					1	7.65	5	24.14
Sub-total	23	639.63	103	830.96	5	32.70	131	1,503.29
Micro Enterprises								
Rigid Polyurethane			49	4.36			49	4.36
Flexible Polyurethane					1	0.01	1	0.01
Integral Skin					3	0.00	3	0.00
Sub-total	0	0.00	49	4.36	4	0.01	53	4.37
Ineligible Enterprises								
Rigid Polyurethane			1	9.29			1	9.29
Flexible Polyurethane							0	0.00
Integral Skin							0	0.00
Sub-total	0	0.00	1	9.29	0	0.00	1	9.29
Total Foam Sector	23	639.63	153	844.61	9	32.71	185	1,516.95

4.3 Eligibility Criteria for Funding to Foam Enterprises

Eligibility criteria for funding are mainly governed by the ExCom guidelines and/or the approved HPMP project document. DIW and GSB will review the documents submitted by enterprises to determine the enterprises' eligibility based on the criteria set forth by the Multilateral Fund below.

- Priority will be given to enterprises established prior to September 21, 2007 (DIW);
- The level of financial support will depend on (i) the enterprise's baseline equipment, (ii) the documented level of HCFC-141b consumption of each individual enterprise and (iii) the percentage of the developing country ownership and export share to countries that are not non-Article 5 countries (GSB).
- Individual enterprise must legally register with government authority (DIW).
- Individual enterprise must have qualified financial capacity to implement the sub-project (GSB).

4.4 Public Consultation

The Project Stakeholder Consultation of Environmental Management Framework (EMF) for the Foam Sector under HCFC Phase out Project was organized at the Department of Industrial Works (DIW) on September 6, 2013 during 9.30 am-12.30 pm. There were 48 participants from 10 polyol suppliers/system houses, 9 foam enterprises that will be converting to cyclopentane technology, Polyurethan Group of the Federation of Thai Industries (FTI), Treaties and International Strategies Bureau of DIW, Industrial Cluster 3 Bureau of DIW, Industrial Cluster 4 Bureau of DIW, Central Office for Machinery Registration of DIW, Bangkok Fire and Rescue Department of Bangkok Metropolitan and Administration (BMA), Department of Labor Protection and Welfare and the Department of Public Works and Town & Country Planning participating in this consultation workshop.

The main objective of this consultation workshop was to present outcomes of EMF preparation comprising of general risk assessment for foam sector, local regulations applicable for the foam enterprises regardless of selected alternative, local regulations specific for enterprise to convert to cyclopentane technology, characteristic of raw materials used for the production of foam and proposed mitigation measures for the conversion to alternatives to HCFC-141b in the foam sector.

More details of the consultation and stakeholders recommendations are provided in Annex I. Key recommendations are summarized in the following:

- Separation of mitigation measures for different types of alternative technologies and re-investigation whether storage of cyclopentane in the tank must comply with the regulations issued by the Excise Department will be reflected in the final EMF;
- Education on classification of the zoning area for design of the plant layout, education of handling of cyclopentane in line with the local regulations, technical advice regarding criteria for selection of alternative technology for foam blowing agent will be conducted through the workshop before the conversion take place;
- A site visit to domestic refrigerator manufacturers which would allow the enterprises to learn operation with cyclopentane technology will be conducted before the conversion take place;
- Training and awareness for plant workers and firefighting offices will be conducted during the conversion process.

5. Legal and Regulatory Framework Requirements

5.1. General provisions of all foam enterprises under HPMP Stage I

This section is only to highlight the laws and regulation that relevant to processes, activities in foam sector. The name of the laws or regulation mentioned in this section is intended for pointing out a very minimum safety, health and environmental requirements and standards that the enterprises should always comply in order to ensure that the potential hazards and risks have been controlled at a minimum, reasonably and practically acceptable level. The Foam enterprises participating in the HCFC phase-out project must comply with all relevant safety, environmental and occupational health provisions in applicable national and local laws and regulations. There are a number of Safety, Occupational health, workplace environment, chemical and substances handling, storage, and transportation and so on that pertain to all kind of industry in Thailand. The ways that laws and regulatory requirements are enforced are through; licensing and permission control, inspection and reporting by the appointed inspectors, and the mandatory requirements for the enterprise to establish in-house management systems and report back to the governing authority on regular basis.



Figure 5- 1 Illustrate the hierarchy of Laws and regulations in Thailand.

5.1.1 Implication of Factory Act B.E. 2535 (1992) for safety standards and licensing

This act is empowered Ministry of Industry to regulate and make sure that industrial sector in Thailand are built their factory building and utilities, install machineries and equipment, operate their production in a way that causes no harm to workers, community and environment. To achieve that general aim, the authority uses their power through the process of granting licenses to the enterprises.

Chapter 1 “Engagement in a Factory Business” Section 7 The Minister shall have the power to prescribe the ministerial rules fixing the factory of any type, kind or size to be the group 1 factory, group 2 factory, or group 3 factory as the case may be by taking into consideration the necessity for the control, prevention of nuisance, prevention of damage, and prevention of danger in accordance with the gravity of impact on the public or environment by classifying as follows

- **Group 1 factory** are such factory of the type, kind and size as capable of engaging in a factory business immediately upon desire of a person engaging in a factory business.

- **Group 2 factory** are such factory of the type, kind, and size as, when engaging in a factory business, must be notified in advance to the Grantor.
- **Group 3 factory** are such factory of the type, kind, and size as to be granted a permit prior to the engagement.

Regardless of the group classification of foam factory, all form manufacturing factory must comply with the provisions set forth in the Factory Act B.E. 2535 (1992). Section 8 of the Factory Act B.E. 2535 (1992) empowered the Minister of Ministry of Industry to issue the ministerial rules which any or all groups of factory under Section 7 must comply with respect to ensuring that the criteria relating to the location of factory, environment of the factory, the nature of the building- in another word, safety of the building are satisfied. On this section, Item (8) also mention the requirement for having safe operations in order to prevent or stop or mitigate the dangers or injuries that may result from the engagement in a factory business. Therefore, all foam sector factories that are licensed to operate shall have safe building and structure, ensure that machineries and equipment are installed and operated in a safe manner, by using proper trained and qualified workers, and fulfill the requirements to have protection against injury and illness.

Although, Section 1 clause 18 (1) of Factory Act B.E. 2535 (1992) is all about renewal of the factory license and the permission for expansion or making modification of the factory building, increasing the capacity of the machineries. Assumingly, the fundamental criteria to grant a renewed license to any group 3 factories, the authority should take into his or her consideration that the compliance to the previous sections that require safe building, well protected from fire and explosion, safe working conditions, proper guarded machines, good electrical set up, no fire or explosion risk, etc.

5.1.2 Building, and Fire safety

The enterprise participating in this HPMP stage 1 must have the current license for utilization of factory building and the inspection recorded issued by the local authority in accordance with Building Act B.E. 2522 (1979). Although, there is no direct statement on this particular law about safe building, having fire protection system, installing the right type of electrical equipment, etc. the licensing process totally relies on an authorized inspector to grant a permission for occupying a building. On clause 8 of this law set a general requirement toward the authority to ensure that the building are safe, fire protection are adequate, electrical, gas and all kind of utilities are installed at safe standards.

The requirement regarding fire prevention/ protection had been revisited seriously after a disaster in a toy factory in B.E. 2535 (1992) that claimed many lives. Fire prevention and control Act. B.E. 2542 (1999), issued by Ministry of Interior, in responding to that incident. This act, define meaning of the term; “Fire prevention” and “Fire control” on clause 4. The detail of this Act aims to empower the local authorities to have the power to make suggestion to the owner of any building to meet “General standards for prevention and control fire”.

Ministerial Order B.E. 2552 (2009), “Fire prevention and control in a Factory” issued by the Ministry of Industry, enacted by the Factory Act B.E. 2535 (1992), Chapter 1 General, Item (3) define the meaning of the factory that is high risk of fire (48 types of factories) and the meaning of the factory that medium risk of fire (other types of factories). Depending on type of finished product, the foam factories are registered as factory type

53 (ice box and thermoware), 63 (sandwich panel), 70 (commercial refrigerator), 77 (automotive part) etc. Based on the Regulation, these are not in the list of factories having high risk of fire. Therefore, it could be concluded that foam factories are classified as the factory having medium risk of fire. However, this regulation provide general guidance for providing ADEQUATE fire protection system including detection and alarm system, portable fire extinguishers, (only this part that relevant to classified fire risk), fire water, and sprinkler. This regulation also suggests periodic inspection, testing and maintenance on the fire protection system, establishment of fire emergency plan, setting up evacuation plans, providing training for the employee, and maintains test records for inspection by the authority.

5.1.3 Workplace, Safety, Health and environment

In general the enterprises are obligated to ensure safe workplace as defined by the clause 4 and 6 of Occupational Safety, Health and Environment Act B.E. 2554 (2011), which was issued by Ministry of Labor and Welfare. Interestingly, this act does not mention fire, or any hazardous material, gases, or electrical, etc. in particular. The law generally defines the meaning of the term; “Safety, Occupational Health, and working environment means actions or working conditions that free from endangering to life and death, physical harm, mental harm, affect to health due to working environment”. The employer is responsible for providing safe, working environment to protect workers from the said “Harm”. Therefore, the expectation toward the foam factories owners is to prevent their workers from fire hazards as well as the other types of hazards. The law also requires employer to formulate management plans to ensure the safe workplace is provided. The layout and condition of buildings and structures are designed and maintained to eliminate or effectively control ergonomic risks, manual handling risks, exposure to noise, exposure to atmospheric contaminants or hazardous substances, such as Isocyanate, Polyol, blowing agents, solvents, mold release solution, hydraulic oil, etc. Exposure to extreme temperatures such as plastic molding, pre-heating, operating oven have to be annually monitored and report the result to the Department of Labor protection and Welfare. Housekeeping standards are communicated and maintained, including arrangements for: safely storing tools, equipment and materials when not in use ensuring that passageways, pathways, aisles, emergency exits and equipment are not obstructed maintaining the cleanliness of work areas and amenities identifying and removing any slip and trip hazards.

5.1.4 Fire emergency preparedness

All Foam factories must comply with the minimum standard set forth by Ministerial Notification of Ministry of Industry Subject Factory Fire Prevention and Control B.E. 2552 (2009), Ministerial Regulation of Social welfare and labor protection Ministry subject Establishment standard of Safety, Health and Working environmental management system for fire prevention and control B.E. 2555 (2012).

Safe working places minimum safety standard in relation to building and facility arrangement includes Safe access and egress shall be provided for personnel during normal and emergency conditions, including appropriate entry and exit from the building or structure, designated working areas, common areas, emergency assembly area.

Ministerial Order B.E. 2552 (2009), “Fire prevention and control in a Factory” issued by the Ministry of Industry, enacted by the Factory Act B.E. 2535 (1992) Chapter 7 require

fire prevention and control training for the employee to be provided on annual basis. Although this law says not thing about “Emergency Response” but the intention of training people to know what to do when they see a fire, how to use portable fire extinguisher, and where to go when they have to evacuate.

Ministerial Regulation B.E.2555 (2012), Establishment of management system for safety, occupational health and working environment – Fire prevention and control clause 30 requires the workplace to have effective emergency response plans. This law does not specify that the workplace must have emergency plan for LPG leak, an emergency plan for Cyclo-pentane leak, fire in plastic mold shop, etc. It is the responsibility of management to think what scope of their emergency response plan should be.

For the potential cases such as the spill or leakage of cyclo-pentane, the safe workplace and laws and regulations that specify the need to have adequate fire protection equipment have been mentioned earlier. In addition, there are needs for proper maintenance and inspection of firefighting, arrangement of fire emergency plans and evacuation drills. Moreover, best industrial standard practices suggest that;

“The site manager or their delegate shall identify Potential emergency situations on, or in the vicinity of, the workplace and develop a Site Emergency Response Plan. Emergency procedures are documented and regularly reviewed. Each workplace shall have an established communications system that allows effective communication. Each workplace shall establish immediately available internal and external emergency contact details. The site manager or their delegate shall allocate overall responsibility for the control of emergency situations to specific individuals, and shall communicate this information to all employees by completing and displaying the Emergency Response Contacts. Competent personnel shall assess the suitability, location and accessibility of emergency equipment. Emergency and fire-protection equipment, exit signs and alarm systems shall be regularly inspected, tested and maintained. Where required, Cyclo-pentane is classified as hazardous substances, manifests or registers shall be established and shall comply with legislative requirements issued by the Department of Industrial Works - Land transportation of hazardous substance B.E. 2546 (2003). First aid requirements shall be assessed, and the first aid system shall be appropriate to the operational risks.”

5.1.5 Plant equipment and machineries

Foam manufacturing factory should have and maintain their plant equipment, machineries, in a safe condition (Installed, operated, maintained in accordance with acceptable standards).

Section 1 clause 18 (2) of Factory Act B.E. 2535 (1992). Same as discussed above, to grant a renewal or expansion permit or license, the authority shall come across to the judgments if such a changes made at any factory are in safe and meet recognized standards. The illegal expansion of the building without making sure that the basement and the structure of the building can take the increasing load can cause the accident from floor collapsing. Increasing the capacity of the plant equipment affect to the initial safety criteria set out on clause 8 as discussed on the part of building and structure above.

Occupational, Health and Safety Acts B.E. 2554 (2011) Section 4 clause 32 and set out specific safety requirements that the employer of the workplace shall establish a hazard identification and a risk assessment process for all existing plant and equipment in use at

the workplace. Machineries, plant equipment are determined as workplace environment where the workers have to work nearby, work on them, stand on them, put their hands and fingers into them, therefore it is regulated under this act with no doubt.

Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Machinery, Crane and Boiler B.E. 2552 (2009), sub section 1, 2 and 3 relevant to plant equipment safety that requires lock out tag out procedures, testing and recording the critical parts of them.

An appropriate site based plant and equipment database shall be developed and maintained. A Plant and Equipment Risk Assessment shall be undertaken prior to purchasing any new plant and equipment, and during the design or modification of plant and equipment. In addition, the Plant and Equipment Design/Modification Hazard Identification shall be completed. The implication of the mentioned requirement is that the enterprises who are converting there foam blowing from HCFC to Hydrocarbon in the process, either changing machine, equipment, using new blowing agents , altering production process/ task are required to update their identification and risk assessment then submit to the local authority.

International recognized best safety practices regarding plant equipment and machineries suggest, adequate maintenance program that includes inspections, maintenance and cleaning shall be Standard Operating Procedures (SOPs) shall be developed for all medium-to high-risk tasks that are associated with the use, adjustment, cleaning, repair or maintenance of any plant and equipment especially those associated with metering, pumping, and foam blowing machine. There is workplace regulation that specifically requires the employer to establish SOPs and provide adequate training to their worker which is Ministerial regulation B.E. 2549 (2006) Subject: Establishment of management system for safety, occupational health and working environment. All plant and equipment that poses a mechanical/electrical hydraulic pneumatic or kinetic hazard shall be appropriately guarded. This is clearly defined by Section 1 clause 4 of the Occupational, Health and Safety Acts B.E. 2554 (2011). All personnel using plant and equipment shall be equipped with suitable Personal Protective Equipment (PPE). All unsafe plant and equipment shall be identified and quarantined or withdrawn from service.

5.1.6 Electrical system inspection and maintenance

Occupational Safety, Health and Environment Act B.E. 2554 (2011) as mentioned earlier that this act said no word about electrical but very unfortunate that electricity can kill people. Therefore it is a hazard in a workplace and shall be provided in safe condition by the employer.

Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554 (2011), provide better detail regarding electrical safety such as detail on;

Section 1: General

Section 2: Electrical Apparatus

Section 3: Lightning Protection

Section 4: Personal Protective Equipment and Safety Devices or Equipment for Prevention electrical hazards

Ministerial Regulation B.E. 2550 (2007) Industrial Electrical standard set out specific electrical safety requirements that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment in all workplaces.

5.1.7 Health and hygiene

There are specific workplace health and safety requirements that pertain to all enterprise.

Occupational Safety, Health and Environment Act B.E. 2554 (2011) and Requirements under Ministerial Regulation B.E. 2547 (2004) issued by Ministry of Labor and welfare, Chapter 1, Item 1 set out specific health surveillance requirements that every workplace shall enforce in order to meet their legal responsibility of providing a safe working environment. The following minimum mandatory requirements shall be implemented to ensure workplace compliance in relation to health surveillance: Prospective employees and relevant contractors shall participate in a pre-placement medical assessment using the Pre- and Post-Placement Health Assessment, Health assessments shall be conducted regularly for all employees involved in driving forklift, transportation of the products, off-site technical support team, etc.

5.1.8 Discharge, emission, and Waste management

Section 1 clause 8 (5) of Factory Act B.E. 2535 (1992) requires that the licensed factories shall always comply with the established standard for discharging waste, emitting pollution, or causing environmental impact to the surrounding area.

In general, foam production process does not generate waste water and emission of air contaminants. The enterprises, however, shall ensure that there is a well control of the storage area where chemicals are stored properly to avoid spills and leakage incidents. The storage area of Cyclo-pentane and other chemicals shall be provided with secondary containment. The capacity of the secondary containment is 1.5 time of the largest chemical container stored in that storage area. For example, if the largest containers of the chemical is 200 liter, the secondary containment should be able to contain 200 liter plus 100 liter.(Reason for this is to ensure there is no overflow or spill out of the secondary containment when it rain).

As mentioned above that spill and leakage handling procedures shall be established. The arrangement of secondary containment around those areas is required. Ministry of Industry has issued a ministerial order number 2 B.E. 2539 (1996) subject discharged waste water standard criteria that have to be always complying.

There is Notification of the Department of Social Welfare and Labor Protection, Ministry of Labor and Welfare subject Guidance for transportation, storage, handling and disposal of chemical and hazardous substance packages B.E. 2535 (1992), item 12, and also the disposal of solid waste and unused material from foam manufacturing factories shall meet requirement specified by the Ministry of Industry order B.E. 2548 (2005) subject Disposal of debris and unused material. (issued by Ministry of Industry). To always comply with this regulation it is suggested that the enterprises to arrange for;

- Waste storage area where segregate non-hazardous waste and hazardous waste.
- Labeling empty drums of chemical, oil, lubricants to prevent unexpected accident or misused if those chemical containers are to be taken by scrap buyer.
- Inspections and ensure that there is no contamination to soil, and water
- manifesting document shall be kept and available for inspection by the authority
- Record-keeping; and Reporting requirements.

Table 5- 1: Summary of National Laws and Regulations for Foam Sector Enterprises applicable to HPMP Stage I

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
Factory license, renewal and permission for expansion, modification production facility (if there is)	Factory Act B.E. 2535	Section 1 clause 18- Expansion of the existing factory require permit.
Modification on existing building to accommodate new equipment, or building new facility for foam blowing machine, storage facility require proper hazard identification and risk assessment to be completed. The permission before modification and commissioning of new/ modified plant equipment shall be granted by DIW.	Building Act B.E.2522	Section 3 Construction, modification, demolition, or changing the purpose of using the building requires permission from local authority. Additional requirement for fire protection, fire exits, electrical safety requirements shall be identified and fulfill.
The need to review workplace safety procedures.		
Alteration of working process, using new chemical, changing work methods for foam blowing process has higher occupational health and safety or fire risk require complete risk assessment and development of Standard Operating Procedure. The operators shall be trained. Proper Personal protective equipment shall be provided.	Ministerial regulation B.E. 2549 Subject: Establishment of management system for safety, occupational health and working environment.	Section 1 Item 5 Standard Operating Procedure has to be revised. The workers who are to be assigned to work on new equipment, new processes, and exposure to new chemical have to be trained and be competent.
Discharge, Emission and Waste Management		
Discharge, Emission and Waste Management shall comply with the followings:	Factory Act B.E. 2535	Section 1 clause 8 (5) requires that the licensed factories shall always comply with the established standard for discharging waste, emitting pollution, or causing environmental impact to the surrounding area
	Notification of the Ministry of Industry number 2	The Characteristic of Waste Water Discharged from Factory has been

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
	subject: Characteristic of Waste Water Discharged from Factory B.E. 2539	defined in Notification of the Ministry of Industry number 2
	Notification of the Ministry of Industry Subject: Provide types and quantities of pollutant that has been vented or drained from factory B.E. 2550	Waste water drainage system and air emission from the factory has been report the types and quantities to Ministry of Industry

See detailed list of other relevant laws in Annex B

5.2 Specific provisions undertaken by foam enterprises converting to HFC-245fa or water blown technology

HFC-245fa has no flash point (as tested by ASTM D3828-87; ASTM D1310-86) and no flammable limits in air (as tested by the procedure UL-2182 at 100 deg C test temperature, 50% ambient air humidity). The auto ignition temperature is 412 celcius as tested in 500 ml flask and 704 celcius as tested in 160 ml flask. In case of accidental release, the spill clean up can be made through soak up with sawdust, sand, oil dry or other absorbent material.

HFC-245fa may cause frostbite, if liquid or escaping vapor contacts the skin. Frostbite may occur if the liquid or escaping vapors from HFC-245fa contact the eyes. It may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation, or the effects of exclusion of oxygen with grossly excessive exposures.

More information on HFC-245fa including polyol and isocyanate is in Annex H of this EMF.

Therefore, for foam enterprises that convert to HFC-245fa and water as foam blowing agents, there are no legal restrictions or requirements regulating such conversion. Given the similar nature of the previously used and the new blowing agent and no significant changes in the foam production process, the existing SOP with appropriate updates to accommodate the use of HFC-245fa and water will still apply and should be sufficient to address environmental and safety concerns.

5.3 Specific provisions of foam enterprises converting to Cyclo-pentane

Cyclopentane chemical and physical properties is discussed below:

CAS No: 287-92-3
Index-Nr. 601-030-00-2
Chemical formula C₅H₁₀

Classification according to Regulation (EC) No 1272/2008/EC (CLP/GHS) as flammable liquid: Flam. Liq. 2 Highly flammable liquid.

Although Cyclo-pentane is not listed as hazardous substance under the Hazardous Substances Act B.E. 2535, its flammability necessitates that the storage and transportation of Cyclo-pentane must comply with Chemical and Hazardous Substance Manual established and announced by the Department of Industrial Works B.E. 2550 and Decisions of the Hazardous Substances Committee Subject Land Transportation of Hazardous Substances B.E. 2555.

Cyclo-pentane has aquatic chronic 3 - Harmful to aquatic life with long lasting effects by Classification according to Directive 67/548/EEC & 1999/45/EC: F; R11 | R52-53 Highly flammable, Harmful to aquatic organisms. May cause long term adverse effects in the aquatic environment.

Cyclo-pentane, in particular, can cause dizziness, nausea, and vomiting; if concentrated vapor is inhaled. It may cause unconsciousness and collapse. Vapor causes slight smarting of eyes. Contact with liquid causes irritation of eyes and may irritate skin if allowed to remain. Ingestion causes irritation of stomach. Aspiration produces severe lung irritation and rapidly developing pulmonary edema; central nervous system excitement followed by depression.

Flammability:

Cyclo-pentane has extremely low flash point at - 30°C that means at the room temperature of foam production plant in Thailand throughout the year, it vaporized if there is a spill/leak or leave the lid of Cyclo-pentane drums opened. When Cyclo-pentane is mixed with the air, it can be ignited if the concentration reach it's flammable limits in air: (approx.) 1.1%- 8.7%. In the production area where Cyclo-pentane is to be used, stored require strictly enforcement of eliminating ignition sources from; open flame from blow torch at the plastic molding process,(which can exceed Cyclo-pentane auto-ignition temperature), electrical spark/ arcing from poor installation of wiring, extension cables, electrostatic charge from poor bonding and grounding, use of hand tools and powered hand tools such as electrical blender which is not explosion proof tools near the area where Cyclo-pentane vapor is generated, or ignition sources from electronic devices that the operator carries into the working area. These potential risk has to be controlled by effectively implementation of hazardous are classification and control procedure and re-arrangement of work process so that all ignition sources from the other area are moved away from hazardous zone. The investment of converting to Cyclo-pentane therefore include re-layout the production, or isolating the area with some form of fire compartment and the installation of explosion proof electrical equipment in the area near where Cyclo-pentane is stored, dispensed, mixed and at the injection of the foam.

More information on Cyclo-pentane including polyol and isocyanate is in Annex H of this EMF.

Pursuant to the above, for companies that plan to use Cyclo-pentane as blowing agent, they must guard against fire hazards and explosions related to the use of hydrocarbons in the production process and observe applicable laws and regulations on safety and occupational health, in particular related to:

- The storage facility for Cyclo-pentane shall meet safety requirement specified by Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550 (2007). The manual is available for download at the website "<http://eis.diw.go.th/haz//hazard/pdf/pagad-kep-2550.pdf>"
- Storage tank/vessels (above ground or underground) welding and pressure test acceptance test shall be completed and meet the Engineering Association Guidelines or recognized international standard such as American Society of Mechanical Engineers code (ASME). (*American Petroleum Institute, Welded Steel Storage for Oil Storage, Standard No. 620, American Society of Mechanical Engineers, ASME Boiler and Pressure Vessel Code, Code for Unfired Pressure Vessels, Sec.VIII, Div. 1., Underwriters Laboratories Inc., Standard for Steel Aboveground Tanks for Flammable Liquids.*)

According to Ministerial Regulation of the Ministry of Interior, Subject: "Construction of other type of the structure that is classified as a building under Building Act B.E.2544". Item (1) A construction of the following structures are to be regulated by the Building Act B.E. 2522; Item 1 Construction of storage tank with capacity 100 cu.m. or above. Therefore, the construction of Cyclo-pentane storage tank that is 100 cu.m or larger shall obtain construction permit in accordance with the Building Act B.E. 2522 (1979)

Chapter 3, Construction, modification, dismantling, relocate, or use for other purpose, clause 21. The local authority at the Department of Public Works and Town & Country Planning usually request all detail relevant to engineering design, calculation sheets, plan and drawing to be submitted.

- Underground storage tank is not recommended unless there is an installation of corrosion prevention such as cathode system. Well design for leak detection is required.
- The design and construction of fire protection system for storage facility of Cyclo-pentane shall meet requirement specified by Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550 (2007) or recognized international standard such as NFPA 30, Flammable & Combustible Liquids Code.
- Vent pipe of the Cyclo-pentane storage tank must has vapor recovery or flare system. Open vent is not recommended since Cyclo-pentane has very low flash point. (Reference: American Petroleum Institute, Venting Atmospheric and Low Pressure Storage Tanks, Standard No. 2000.)
- The storage area of Cyclo-pentane shall be provided with secondary containment. (refer to 5.18)
- Delivery and storage of Cyclo-pentane at the production facility shall be made in safe manner to prevent spill, leakage, fire and explosion. The condition of the trucks shall be complying with Notification of the Ministry of Industry Subject: Hazardous Substances Land Transportation B.E. 2546 (2003). There also safety requirement that is applicable for transportation of Cyclo-pentane set forth by the Decision of the Hazardous Substances Committee Subject Land Transportation of Hazardous Substances B.E. 2555 (2012).
- Pre-mixing of Cyclo-pentane with Polyols to be performed only in the explosion proof area.
- electrical installations in accordance with area classification / grounding of foaming equipment and jigs in areas where Cyclo-pentane is stored or used (National Fire Protection Association, NFPA 69, Explosion Prevention Systems)
- General fire safety measure in and around the foaming area. In the foam area is classified high fire risk. General fire safety prevention measures such as the prevention of ignition sources shall be strictly enforced. Safety signs to prohibit making source of heat, sparks, by any hot work shall be posted. Unauthorized, non-intrinsically safe electronic devices must not be allowed in this area.
- Ventilation, gas detectors and firefighting equipment, installed and in good working condition. Ventilation system; general ventilation and local ventilation at the Cyclo-pentane storage area. Because of Cyclo-pentane is heavier than air, it tends to accumulate near the ground level. Well-ventilated area will eliminate the likelihood of Cyclo-pentane in the air at lower flammable limit which can be ignited by the ignition sources. Generally, ventilation can be classified into two types; first is natural ventilation which is mainly benefit from building design and construction to have air movement naturally and no need additional mechanical devices, and second is

artificial ventilation. This type requires mechanical devices such as exhaust fan, hood and ducts. General ventilation is simple way to induce air movement in the building. The use of electric fans from the ceiling, ventilation exhaust fans on the wall are example of the term “General ventilation”. The term “Local exhaust ventilation (LEV)” is a ventilation system consists of hood to capture air contaminants at the source of generation and move it through the duct. The exhaust fans create suction at the face of the hood and make the air contaminant to be ventilated away. For more detail, please refer chapter 3 of “The manual for inspection, installation of electrical system in a factory where volatile flammable substance are used”. This manual was issued by the Office of Safety Technology, Department of Industrial Works, Ministry of Industry, June B.E.2548 (2005).

Gas detection and alarm system is recommended to be installed at;

- a. Cyclo-pentane storage area
- b. Foam production area
- c. Jigs and mold where foam blowing is taking place.

Flammable gas detectors can make a valuable contribution to the safety of these processes. They can be used to trigger alarms if a specified concentration of the gas or vapor is exceeded. This can provide an early warning of a problem and help to ensure people’s safety. However, a detector does not prevent leaks occurring or indicate what action should be taken. It is not a substitute for safe working practices and maintenance.

Detectors can be fixed, portable or transportable. It is recommended to have ‘fixed’ detectors, permanently installed in a location mentioned above to provide continuous monitoring of Cyclo-pentane. The components of a gas detection system include sensors, control unit and alarm. The position of the detection sensors for Cyclo-pentane should be at the low level above ground surface due the fact that Cyclo-pentane is heavier than air and tend to accumulate there. The control unit or control panel of detection system should be located outside of the hazardous zone. The alarm should be installed at the locations mentioned above and at the location where general area can be alerted. It is also recommended that the alarm should be installed at security guard house.

- **Emergency preparedness**

Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552 (2009) issued by the Ministry of Industry, enacted by the Factory Act B.E. 2535 (1992) Chapter 7 require fire prevention and control training for the employee to be provided on annual basis. Although this law says not thing about “Emergency Response” but the intention of training people to know what to do when they see a fire, how to use portable fire extinguisher, and where to go when they have to evacuate.

Ministerial Regulation B.E.2555 (2012), Establishment of management system for safety, occupational health and working environment – Fire prevention and control clause 30 requires the workplace to have effective emergency response plans.

The foam factory shall work with local fire department to develop emergency response plan in particular for reacting with the fire at Cyclo-pentane storage area/storage tank. The plan should include instructions for handling potential situation of Boiling Liquid

Expanding Vapor Explosion which can occur if cooling on the burning containers of flammable liquid is not sufficient. Periodic fire drill should be organized.

The foam sector enterprises participating converting to Cyclo-pentane must comply with all relevant safety, environmental and occupational health provisions in applicable national and local laws and regulations as shown in Table 5-2.

Table 5-2 Summary of Laws and Regulations for Foam Enterprises Converting to Cyclo-pentane Blowing Agent

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
Storage facility design and construction for Cyclo-pentane	Hazardous Substance Act B.E. 2535 Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550.	Criteria for construction chemical and hazardous substance storage facility. Fire rating of the wall, roof, and floor is determined under this regulation. Safety equipment such as emergency light, grounding, bonding requirement are specified. Fire protection and extinguisher is specified by this regulation.
Permission for construction of storage tank size 100 cu.m. or larger.	Ministerial Regulation Construction of other type of structure that is classified as a building under Building laws B.E.2544 (Issued by Ministry of Interior) Item (1) A construction of the following structures are to be regulated by the Building Act B.E. 2522;	According to Ministerial Regulation of the Ministry of Interior, Subject: "Construction of other type of the structure that is classified as a building under Building Act B.E.2544". Item (1) A construction of the following structures are to be regulated by the Building Act B.E. 2522; Item 1 Construction of storage tank with capacity 100 cu.m. or above. Therefore, the construction of Cyclo-pentane storage tank that is 100 cu.m or larger shall obtain construction permit in accordance with the Building Act B.E. 2522 Chapter 3, Construction, modification, dismantling, relocate, or use for other purpose, clause 21. The local authority at the Department of Public Works and Town & Country Planning usually request all detail relevant to engineering design, calculation sheets, plan and drawing to be submitted.
Workplace health and safety requirement that require additional SOP, training and protection for the worker who expose to Cyclo-pentane.	Ministerial regulation B.E. 2549 Subject: Establishment of management system for safety, occupational health and working environment.	Section1 Item 5 Standard Operating Procedure has to be revised. The workers who are to be assigned to work on new equipments, new processes, and exposure to new chemical have to be trained and be competent.
Revise emergency response plan	Ministerial regulation B.E. 2555 Subject: Establishment of management system for safety, occupational health and working environment, Fire prevention and control	Section 1 Item 2 The emergency response plan shall be revised to cover possible scenario of Cyclo-pentane uncontrolled release, spill and leakage handling procedure. Section 1 Item 6 Update SOP and provide additional training for the employee so that they are fully aware off the additional fire hazard from handling Cyclo-pentane.

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
<p>Safety requirement for transportation, storage, transfer, handling and disposal of chemical and hazardous substances drums, or small containers of Cyclo-pentane</p>	<p>The Department of Social welfare and labor protection Notification Subject: Safety requirement for transportation, storage, transfer, handling and disposal of chemical and hazardous substances drums, or small containers B.E. 2535</p> <p>Ministry of Industry Subject: Hazardous Substances Land Transportation B.E. 2546.</p> <p>Decision of the Hazardous Substances Committee Subject Land Transportation of Hazardous Substances B.E. 2555.</p>	<p>Transportation safety, vehicle inspection, training requirement for the driver, color code for chemical piping, etc.</p> <p>The driver who delivers Cyclo-pentane shall be inducted to understand site safety rules and follow critical procedures not only for driving on the road, but on the site as well.</p> <p>Delivery and storage of Cyclo-pentane at the production facility shall be made in safe manner to prevent spill, leakage, fire and explosion. The condition of the trucks shall be complying with Notification of the Ministry of Industry Subject: Hazardous Substances Land Transportation B.E. 2546. There also safety requirement that is applicable for transportation of Cyclo-pentane set forth by the Decision of the Hazardous Substances Committee Subject Land Transportation of Hazardous Substances B.E. 2555.</p>
<p>The foam factory to have and use Cyclo-pentane are require to appoint a competent personnel to be responsible for ensuring safety of storage, handling and use of hazardous substances under the supervision of Department of Industrial Works.</p>	<p>Notification of Ministry of Industry Subject: Storage of hazardous substances which fall under supervision of Department of Industrial Works B.E. 2551</p> <p>Notification of Department of Industrial Works Subject: Qualification and reporting criteria for appointment of the competent personnel to be responsible for reporting safety performance of storage of hazardous substances which fall under supervision of DIW B.E. 2551</p>	<p>Storage tanks, storage facility of Cyclo-pentane in foam factory to be supervised by a competent personnel who have been appointed, pass the examination and meet the criteria set up by DIW.</p>
<p>Cyclo-pentane is classified as hydrocarbon solvent due to the fact that its' final boiling point is 49.2 C^o</p> <p>The factory where Cyclo-pentane to be used for industrial process that eligible for tax reduction is to be inspected by the official. The inspection is mainly for the validation of tax reduction purposes. However, the inspection procedure require the official to gather information relevant to production process and general environment in additional to the</p>	<p>The Notification of Ministry of Finance Subject Defined characteristic of Hydrocarbon Solvent B.E. 2552 enacted by the Excise Taxation Act B.E. 2537, revision 2 clause 103. The Minister of Finance to define the characteristic of hydrocarbon solvent listed on the category 01.90(3) Item 1 The hydrocarbon solvent that has final boiling point not exceed 400 C^o in accordance with ASTM D86 test method, is to be defined as hydro carbon solvent.</p>	<p>The inspection by the appointed official to be performed for validating the qualification for tax exemption for Cyclo-pentane.</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
data for tax calculation.	<p>Notification of Ministry of Finance Subject Criteria and condition for tax exemption for hydrocarbon solvent that is used for industrial production process B.E. 2552</p> <p>Item 1 Hydrocarbon solvent is a hydrocarbon solvent that has characteristic as prescribed by the Minister of Finance.</p> <p>The Procedure for inspection the enterprises who are the suppliers of hydrocarbon solvents, and the inspection at the facility of the users of hydrocarbon solvents for industrial purposes B.E. 2554</p>	

Summary of Safety Criteria for storage area for Cyclo-pentane are in Annex C of this Environmental Management Framework (EMF).

6. World Bank Safeguard Policies

The project activities will likely occur in the existing facility, for which no land acquisition is required. Even though cyclo-pentane will be used, of which, may create safety and occupational health issues. Since not all the foam beneficiaries have been identified by appraisal, an Environmental Management Framework (EMF) has been prepared to provide guidance to all stakeholders including the DIW and beneficiary enterprises to effectively identify and address environmental safeguard issues that may arise from the proposed sub-project investment. The EMF also includes a template of the Environmental Management Plan (EMP). Beneficiary enterprises will use the EMF and template of EMP to prepare their own EMP that environmental safeguard issues are properly addressed during the conversion to alternative technology. Therefore, the Project is assigned as an Environment Category B Project and triggers the World Bank's Operational Policy (OP)/Bank Procedure (BP) 4.01 - Environmental Assessment (EA).

The World Bank's Operational Policy OP 4.01 applicable to the project investments provides guidance on objectives and principles regarding environmental and social safeguards management for Bank-funded operations. The HCFC Phase-out Project is a category "B" project, which requires the client to prepare an EMF prior to appraisal. An excerpt of the applicable policy is below.¹

World Bank Safeguard	Abstract
Environmental Assessment (EA) (OP 4.01)	EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The Bank favors preventive measures over mitigatory or compensatory measures, whenever feasible.
WBG Environmental, Health and Safety (EHS) Guidelines	The WBG Environmental Health and Safety Guidelines (EHS) are technical reference documents with general and industry-specific examples of Good Industry Practice (GIP), as defined in IFC's Performance Standard 3 on Pollution Prevention and Abatement. The EHS Guidelines contain the performance levels and measures that are normally acceptable to the World Bank Group and are generally considered to be achievable in new facilities at reasonable costs by existing technology. When host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent.

¹ For more details about WB guidelines and Policies, please visit Bank websites: <http://web.worldbank.org/WBSITE/EXTERNAL/PROJECTS/EXTPOLICIES/EXTSAFEPOL/0,,menuPK:584441~pagePK:64168427~piPK:64168435~theSitePK:584435,00.html> and <http://www.ifc.org/ifcext/sustainability.nsf/Content/EHSGuidelines>

7. Environmental and Other Impacts of the Alternative Foam Blowing Technology Introduced under this Project

HCFC Phase-out Management Plan has a clear goal to reduce depletion of ozone layer while striving for the lowest global warming impact by freezing and reducing consumption of HCFCs. Positive and negative impact on environment is also being assessed in this Environmental Management Framework from the angle that how positive impact will be from adopting alternative blowing agent with fully equipped machineries when compared to the existing conditions of producing foam in Thailand. Some of the small and medium size enterprises currently use hand-mixing method for foam production. More precisely, foam metering and dosing are done manually by weighing scale. After metering, the enterprises mix and pour foam into the molds by hand. Under the HPMP Stage I, the foam enterprise will receive financial assistance to acquire foam injection machine. There are significant and positive impacts on environment from changing to well-designed foam injection with more precise metering and dosing system. Firstly, the foam injection machine helps to improve the productivity and quality of the product. Secondly, the foam injection machine reduces evaporation when compared to the hand-mixing method for which dispensing, mixing and pouring are done manually. The reduction in evaporation also leads to the less exposure to the chemicals used in foam formula. Thirdly, the improvement of accuracy of mixing from the foam injection machine leads to less solid waste. Foam production impacts the environment when (part of) the blowing agent and/or other chemicals used in the foaming process are emitted to the environment from storage containers, during the production process or in the use of the final product. Close circuit feeding system, dosing and metering unit and PLC controlled injection system take away the emission from manual production method.

Main impacts of the phase-out of HCFC:

- a) **Ozone depletion:** The phase-out by the project of HCFC as blowing agent will contribute positively to the recovery of the ozone layer. HFCs and Cyclo-pentane are ozone neutral.
- b) **Global climate change:** HCFCs and HFCs are greenhouse gases with different global warming potentials (GWP). Due to a reduced formulation of HFC-245fa in foam blowing, the impact on the global climate due to switching from HCFC to HFC is by and large neutral, whereas switching to Cyclo-pentane results in 95% reduction of GHG emissions compared to HCFC141b.
- c) **Local air pollution:** While HCFC and HFC-245fa are chemically stable and do not affect local air quality, Cyclo-pentane is a volatile organic compound (VOCs), which can contribute to fugitive emissions and ground-level smog pollution when leaked to the surroundings. Cyclo-pentane is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals; the half-life in air is approximately three days. It is estimated that emission of the blowing agent is limited to 2-3%. While the environmental impact of this emission is not significant, emissions from the foam blowing process will be contained through regular leak inspections.
- d) **Soil and water pollution:** Other chemicals involved in foam production are methyl diisocyanate (MDI), amine catalysts and fire retardants. The probability that a spill of polymeric MDI (liquid at room temperature) contaminates the soil and water is very low, because the floor of the foam production areas consists of cement coated with an anti-leakage, low permeability chemical layer such as epoxy. If MDI leaks into the soil, it will react with moisture or water, and the reaction would result in CO₂ and insoluble polyurea compounds, which are not biodegradable and chemically inert. Fire retardant and amine catalysts (very small amount) are mixed with polyol by system house suppliers. They remain in the final foam products and are not emitted to the environment during foam production or later.
- e) **Fire hazard:** HFC-245fa and water are not flammable substances. Therefore, there is no fire hazard impact from the use of HFC-245fa and water as blowing agent. Cyclo-pentane is a flammable liquid. Well-designed machineries, elimination of ignition sources by applying intrinsically safe equipment and strictly controlled of the other ignition sources by proper

arrange production zone in accordance with the International Electrical Code is possible to offer safe and healthy production system.

- f) **Occupational health and safety:** The phase-out of HCFCs and conversion to alternative technology will associate with the change of blowing agent. Other raw materials used for the foam production comprising of polyol and isocyanate are still the same (with some adjustment in formulation). Personal Protective Equipment (PPE) should be worn to prevent possible exposure to the chemicals used for the foam production.

- g) **Solid waste management:** The positive side of implementing this project is that the enterprises currently use hand-mixing method; there is residue of PU foam remained in the mixing cups. For 131 enterprises that opted for this investment component, the project will help the enterprises to acquire foam injection machine and the residue of PU foam remained in the container will be eliminated. In some PU foam applications, there is residual of PU foam from the finishing process. The use of foam injection machine would allow the enterprise to minimize the excess PU foam due to the precise accuracy of foam metering through the foam injection.

The Decision of the Executive Committee of the Multilateral Fund requires that the existing foam injection machine that has been replaced by the new machine must be properly disposed or made unusable. The disposed foam injection machine will be then sold to the scrap buyer, who will subsequently disassemble the unit for further process. Doing these, the participating foam factory shall follow the requirement regarding unused material disposal specified by law. The scrap buyer shall be notified that the vessels, piping, and equipment have to be carefully disassembled and avoid using cutting torch on them.

8. Mitigation Measures - Environmental Management Plan

8.1 Environmental Management Plan

- The preparation of an EMP is a project requirement for foam sector enterprises that convert their foam production to the use of Cyclo-pentane as blowing agent.
- Given that there is no fire hazard impact from the use of HFC-245fa and water as blowing agent, enterprises that convert to HFC-245fa or water blown technology do not need to prepare an EMP, but are required to update and follow their Standard Operating Procedures (SOP), which will be verified by the PMU.

For companies converting to Cyclo-pentane, the safety requirements associated with the use of flammable hydrocarbons present operational challenges, in particular for smaller foam enterprises. Therefore, the World Bank's Environmental Assessment (OP/BP 4.01) policy is triggered. Provided the environmental assessment above, participating companies planning to use hydrocarbons will need to prepare a site-specific Environmental Management Plan (EMP) for the conversion to address the safety concerns of Cyclo-pentane use.

Cyclo-pentane is volatile liquids and give off invisible vapors. Either the liquid or vapor may settle in low areas or travel some distance along the ground or surface to ignition sources where they may ignite or explode. This emphasizes the need for re-layout of the area where new foam injection system that Cyclo-pentane is to be used is a critical.

The following are recommended safety control measures that are the key elements of the EMP that should be developed by all enterprises who will use Cyclo-pentane.

8.1.1 Hazard awareness

The enterprises should pay attention to the area where the chemicals used in production of foam comprising Cyclo-pentane, Polyol and MDI are stored and used,

Cyclo-pentane, in particular, can cause dizziness, nausea, and vomiting; if concentrated vapor is inhaled. It may cause unconsciousness and collapse. Vapor causes slight smarting of eyes. Contact with liquid causes irritation of eyes and may irritate skin if allowed to remain. Ingestion causes irritation of stomach. Aspiration produces severe lung irritation and rapidly developing pulmonary edema; central nervous system excitement followed by depression. The enterprises shall educate and provide training to their staffs to acknowledge and realize the implications of cyclopentane and other chemicals used after the conversion.

8.1.2 Personal Protective Equipment

Personal Protective Equipment- PPE shall be provided and strictly enforced. Hydrocarbon respirator equipped with canister shall be provided for the workers during normal operating condition, especially when exposure to vapor.

In case of emergencies, spill or leakage handling, supplied-air, or hose mask (respirator equipped with air line or self-contained air supply through the hose to the face mask); rubber or plastic gloves; chemical goggles or face shield should be worn.

As mentioned earlier that the enterprises who are converting to Cyclo-pentane are required to revised their existing work procedures to cover the hazards listed above and ensure that the workers who are assigned for the task associated with Cyclo-pentane receives adequate training. This is not just a general industrial best practices but it is a legal obligation.

8.1.3 Storage and handling

Requirement specified under Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550 shall be followed. The design of storage tanks must conform to the principles of good engineering practice. Storage tanks should be fabricated with welded steel construction. Underground storage tanks are not recommended, unless equipped with corrosion prevention measures, such as cathodic protection and linings, and equipped with a leak detection system.

For safe handling delivery of Cyclo-pentane from bulk truck, the following safety measures are recommended: Hydrocarbons can easily accumulate static electricity, thereby causing sparking and fire. Loading and unloading facilities should be at least 25 feet from other buildings and warehouses. In addition, provide grounding and bonding facilities for protection from static sparks while loading and unloading. Site shall set up a procedure to monitor the tank level at all times during filling and be prepared to stop the flow immediately, if necessary.

8.1.4 Hazardous area classification

There are different standards used for hazardous areas and electrical equipment designed for use in those environments, depending upon where in the world they are to be used. In Europe, European National (EN) standards are used to gain compliance with the associated electrical apparatus of explosion proof devices (ATEX directives). In the USA the standard is National Electric Code (NEC) with a variant called Canadian Electric Code (CEC), used in Canada. In addition some countries have their own approval standards (e.g. State standard of Soviet Union (GOST), for Russia and the former Soviet States, Thai Industrial Standard Institute (TISI) for Thailand, etc), however these are often based on International Electrical Code (IEC) standards.

Do not use electronic devices (including but not limited to cellular phones, computers, calculators, etc.) in or around any operation involving pentanes or pentane storage areas unless the devices are certified intrinsically safe by an approved national testing agency and comply with the safety standards required by the National Electrical Code Areas of Classification and/or Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550. Electrical equipment and fittings must comply with National Electrical Codes and local fire prevention regulations for this class of product.

Classify all identified hazard areas following IEC 79-10, second edition, 1986:

Table 8-1 Comparison of Hazardous Area Classification Standard

Standards	Flammable gas present at all times	Flammable gas present at normal condition	Flammable gas present at abnormal condition
IEC	Zone 0	Zone 1	Zone 2
NEC 500	Class 1 Division 1		Class 1 Division 2
NEC 505	Zone 0	Zone 1	Zone 2

Example of the area in foam production

Area near to opening port on the 200 liter drum containing Cyclo-pentane.

Area at foam mixing head, inside the mold, near the opening port on the jigs.

Area around the foam blowing machines, mixing pump, day tanks, molds, jigs.

Storage tanks

Storage warehouse for Cyclo-pentane drums

8.1.5 Electrical installation and components

(see item 5.1.6) There are different laws and regulation in Thailand that regulate the standard of electrical installation in the factory such as Ministry of Industry regulation B.E.2550 Standard Electrical System in the factory. Chemical and Hazardous substance manual established and announced by the Department of Industrial Works B.E. 2550 specify standard installation for the storage room of Cyclo-pentane.

8.1.6 Electrostatic charge protection

Static electricity can cause fires and explosions unless certain precautions are observed;

- Do not use product around open flames or sparking equipment such as switches and motors.
- Prohibit smoking and lighters in any area where the Cyclo-pentane is stored, transported, or used.
- Do not use electronic devices (including but not limited to cellular phones, computers, calculators, pagers, etc.) in or around any operation involving Cyclo-pentanes or Cyclo-pentane storage areas unless the devices are certified intrinsically safe by an approved national testing agency and comply with the safety standards required by the National Electrical Code Areas of Classification.
- The flow-rate with which the product is transferred affects the amount of static charge generated. Cyclo-pentanes like the other non-conductive hydrocarbons have a high volume resistivity and can pick up and hold a static charge during transfer operations.
- Key operations which have the potential of generating a flammable atmosphere and/or static, bonding and grounding is necessary. Reference:

National Fire Protection Association (NFPA) 77, "Recommended Practice on Static Electricity"⁶ and/or the American Petroleum Institute (API) Recommended Practice 2003, "Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents.

8.1.7 Detection and alarm system

Detection and alarm system are required for all area where Cyclo-pentane is stored, handling and used. The sensors are to be connected to a centralized control panel in a safe area, clear from potential emission sources. The system shall be capable to trigger two consecutive visual/acoustical alarm levels, related to the percentage LEL reached. Recommended is a first level alarm on 5% LEL and a second alarm level at 10% LEL.

(Explanation: Lower Flammable Limit of Cyclo-pentane is =1.1% , the first level alarm should be set off when the device can detect the leakage of Cyclo-pentane in atmosphere when it concentration hit 5% of 1.1 which is equal to 0.05 percent by volume and the second alarm to be triggered when Cyclo-pentane in the air is = 10% LEL which is = 0.11 percent by volume)

The acoustical alarm shall be a minimum of 85 Db, or at least 15 Db over plant noise level. The visual alarm shall be in the pouring area. The first alarm shall be for warning purposes only. The second alarm shall shut down the pouring operation and the pentane supply, while increasing the process exhaust. The system shall have an independent power back-up. An auxiliary portable gas sensor with calibration unit shall be kept on site.

8.1.8 Ventilation and exhaust system,

General and local exhaust ventilation (Find more detail on 5.3)

8.1.9 Fire protection

Fire protection system required by many laws which are; Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552; the Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Fire Prevention and Control B.E. 2555 and the Notification of the Ministry of Welfare and Labor Protection Subject: Portable Fire Extinguisher Standards B.E. 2556.

Cyclo-pentane is highly flammable. In the situation where Cyclo-pentane is leak out of its system, it will evaporate and turn into gas phase instantly. The density of Cyclo-pentane is more than air, therefore the vapor /gas phase of Cyclo-pentane will move above the ground level and can possibly be ignited by ignition sources away from the location where it was leaking. Flash back along the way can occur. Vapor may cause explosion in confined area. Use dry chemical or CO₂ fire extinguishers.

Cyclo-pentane is lighter than water and insoluble, it could be ignited on the surface of water. Avoid straight stream spraying water directly on the fire. Use alcohol-based foam to fight the fire. To prevent boiling liquid expanding vapor explosion, cool exposed containers with sufficient water. Use unmanned fire hoses or monitor nozzles.

8.1.10 Standard Operating procedure and training

Standard operating procedure and training are required by workplace health and safety laws. These laws are; Occupational Safety, Health and Environment Act B.E. 2554 by Ministry of Labor and Welfare. 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 also set requirements for establish standard operating procedures and provide training to the workers.

Foam enterprises shall develop SOPs and provide effective training for the workers who involve in; shipment/delivery/receiving Cyclo-pentane, storage, handling, mixing, and operating foam blowing systems. SOPs shall cover, bonding, grounding requirement, personal protective equipment, electrostatic and ignition prevention, safety precautions to handle unexpected incident such as spill and leakage regardless of the volume of Cyclo-pentane.

8.1.11 Inspection and maintenance

Detail criteria for designing and installing ventilation system is provided on “Electrical system for the highly volatile and flammable atmosphere in a factory, inspection and installation manual” published by the Office of Safety Technology, Department of Industrial Works, Ministry of Industry, B.E. 2548 (2005)

At least one safety inspection and audit should be completed by the enterprise with assistance of the supplier before the start-up of foam production using Cyclo-pentane. However, as indicated in monitoring plan of the EMP, the DIW will re-confirm whether this audit has been conducted during the pre-commissioning audit. See **Annex D** Pre-Startup Checklist

Template of EMP, which includes data such as foam enterprise’s baseline information and proposed safety measures for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank and delivery of Cyclo-pentane in drums, which will be completed by foam enterprises converting to Cyclo-pentane before conversion takes place, etc. is shown in **Annex E** of this EMF.

8.2 Proposed mitigation measures and capacity building

In addition – and unrelated to the conversion technology supported by the project – all foam producing facilities must implement and observe certain OHS measures related to the use of Isocyanides (MDI), which is one of the chemicals used in foam production and which is a moderate health and environmental hazard. Appropriate precautions must continue to be taken in particular with regard to the followings:

Table 8-2. Proposed mitigation measures for form enterprises under HPMP Stage I

Mitigation Measure (additional to minimum regulatory requirements)	Applicable For	
	Cyclo-pentane	HFC-245fa or Water Blown Formulation
Hazard awareness training for the operator	Mandatory	Optional
Personal protective equipment	Mandatory	Mandatory
Storage facility, fire protection	Mandatory	Optional
Electrical installation, Explosion proof specification	Mandatory	N/A
Electrostatic charge prevention equipment/procedures	Mandatory	N/A
Detection and alarm system	Mandatory	N/A
Local Exhaust ventilation	Mandatory	N/A
Fire prevention and control system	Mandatory	Optional
Standard Operating Procedures	Mandatory	Mandatory
Preventive maintenance and inspection	Mandatory	Optional
Emergency response plans	Mandatory	Mandatory

9. Responsibilities

Responsibilities for the implementation of the mitigation measures are as follows:

Foam enterprises:

Foam enterprises are responsible for the safe conversion from HCFC-141b to Cyclo-pentane or to HFC-245fa/water blown foam production.

HFC-245fa

HFC-245fa has no flash point (as tested by ASTM D3828-87; ASTM D1310-86) and no flammable limits in air (as tested by the procedure UL-2182 at 100 deg C test temperature, 50% ambient air humidity). The auto ignition temperature is 412 celcius as tested in 500 ml flask and 704 celcius as tested in 160 ml flask. In case of accidental release, the spill clean up can be made through soak up with sawdust, sand, oil dry or other absorbent material.

HFC-245fa may cause frostbite, if liquid or escaping vapor contacts the skin. Frostbite may occur if the liquid or escaping vapors from HFC-245fa contact the eyes. It may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation, or the effects of exclusion of oxygen with grossly excessive exposures.

Cyclo-pentane

Cyclo-pentane has extremely low flash point at - 30°C that means at the room temperature of foam production plant in Thailand throughout the year, it vaporized if there is a spill/leak or leave the lid of Cyclo-pentane drums opened. When Cyclo-pentane is mixed with the air, it can be ignited if the concentration reach it's flammable limits in air: (approx.) 1.1%- 8.7%. In the production area where Cyclo-pentane is to be used, stored require strictly enforcement of eliminating ignition sources from; open flame from blow torch at the plastic molding process,(which can exceed Cyclo-pentane auto-ignition temperature), electrical spark/ arcing from poor installation of wiring, extension cables, electrostatic charge from poor bonding and grounding, use of hand tools and powered hand tools such as electrical blender which is not explosion proof tools near the area where Cyclo-pentane vapor is generated, or ignition sources from electronic devices that the operator carries into the working area. These potential risk has to be controlled by effectively implementation of hazardous are classification and control procedure and re-arrangement of work process so that all ignition sources from the other area are moved away from hazardous zone. The investment of converting to Cyclo-pentane therefore include re-layout the production, or isolating the area with some form of fire compartment and the installation of explosion proof electrical equipment in the area near where Cyclo-pentane is stored, dispensed, mixed and at the injection of the foam.

Cyclo-pentane, in particular, can cause dizziness, nausea, and vomiting; if concentrated vapor is inhaled. It may cause unconsciousness and collapse. Vapor causes slight smarting of eyes. Contact with liquid causes irritation of eyes and may irritate skin if allowed to remain. Ingestion causes irritation of stomach. Aspiration produces severe lung irritation and rapidly developing pulmonary edema; central nervous system excitement followed by depression.

More information on Cyclo-pentane, HFC-245fa including polyol and isocyanate is in Annex H of this EMF.

In execution of this responsibility, foam enterprises shall:

Before conversion:

- Request from chemical supplier the safety data sheets for each chemical used in the foam production process.

- Obtain safety specifications for fire protection measures from foam equipment suppliers.
- Obtain approval from fire protection authorities as per local and national requirements.
- Prepare sub-project proposal for the implementation of the conversion project.
- Obtain approval from relevant authorities for storage and use of hydrocarbons (only for conversion to Cyclo-pentane).
- Prepare an EMP for the implementation of the conversion project (only for conversion to Cyclo-pentane).
- Ensure that the operation license is valid
- Disclose EMP to the public through the enterprise's website (only for conversion to Cyclo-pentane).

Before starting production using alternatives:

- Obtain full instructions and training on the safe handling of these chemicals and keep workers continuously trained on all safety and health aspects related to the use of chemicals and foam production.
- Ensure that production managers enforce and workers follow the guidance in safety data sheets and comply with all other safety and environmental requirements when handling chemicals and in the foam production process.
- Make arrangements with an environment servicing company for the collection and disposal of polyurethane waste and empty chemical drums.
- Assign technical staff (e.g. an environmental, health and safety officer) to monitor compliance with (i) all OHS measures and environment requirements and (ii) all safety requirements and fire protection rules when working with Cyclo-pentane during and after the conversion process.
- Arrange for a safety audit and obtain a fire safety certificate from a competent fire protection authority when conversion is completed and before start of production with hydrocarbon.
- Send copies of any environmental, safety and health plans and reports related to HCFC conversion to the PMU for information and oversight.

After start of production:

- Take adequate measures to prevent leaking and spilling of chemicals during storage and manufacturing.
- Respond to chemical contamination and accidents promptly by carrying out mitigation measures to minimize environmental and health impacts of the workers as appropriate for each chemical and step in the production process.
- Prepare safety protocols, procedures and checklists on preparedness for and mitigation of fire emergencies, explosions, accidents, and environmental contamination and keep these documents accessible and regularly updated.
- Conduct monitoring and testing of fire and other safety equipment and procedures regularly following established checklists and procedures, ensure good operational conditions and

promptly replace failing, used up, worn or expired facility and personal safety equipment and materials.

- Prepare and file environmental, safety and health reports if and as required by national or local regulations, and report accidents to the competent authorities:
- Report production and consumption data to the PMU as required (foam produced, HFC-245fa or Cyclo-pentane consumed).

The Project Management Unit (PMU)

The PMU of Department of Industrial Works is responsible for the proper management and oversight of the overall HCFC phase-out project including environmental and safety aspects of each HCFC conversion sub-project. In execution of this responsibility, under guidance from Department of Industrial Works and the World Bank, the PMU will:

- Set up eligible criteria for screening of participating enterprises:.
- Provide technical assistance to participating foam enterprises on alternatives to HCFC-based foam production including their environmental and health risks.
- Review and assess the adequacy of the HCFC conversion plan including the EMP and SOPs of participating companies.
- Include the approved EMP in the sub-grant agreement with each participating foam enterprise such that the responsibilities and commitments in the EMP become contractual obligations of the participating enterprise.
- Supervise the implementation of the HCFC conversion project and the company's compliance with the agreed environmental and safety requirements and standards.
- If necessary, cooperate with competent national and local authorities to enforce environmental, health and safety compliance by participating companies.
- Prepare reports on environmental, health and safety compliance of the overall HCFC phase-out project and provide them to the Bank during supervision missions as required.

Equipment suppliers:

Equipment suppliers are responsible for safe design and installation of the foam production line, in particular when using Cyclo-pentane. In execution of this responsibility, equipment suppliers will:

- Assess the production facility and location and design the foam production line in a manner that will meet all environmental, health and safety standards and requirements.
- Install, or assist with the installation of, the foam production line and related equipment to ensure safe production conditions.
- Provide to the foam production company complete information manuals and operational instructions on the installed equipment and inform customers on any newly emerging safety concerns related to the installed equipment.
- Provide training on the safe operation of the supplied equipment, including environmental and health risks and mitigation measures.

- Provide after-sales services and warranties in the case of accidents due to technical equipment failure.

Chemical suppliers:

Chemical suppliers are responsible for safe transportation of chemicals used for the production of PU foam. There is a set of requirements that need to be fully complied with specified by Ministry of Industry B.E. 2546 Subject Hazardous substance land transportation.

The chemical suppliers are responsible for preparing Transportation Manifest and hold the current license for transportation. Adequate signage shall be clearly visible and displayed as per legislative requirements, and employees in this case is more likely to be the truck drivers of the chemical suppliers shall comply with all signage. Suppliers are responsible for ensuring that the condition of chemical containers is delivered in safe conditions. Containers, tanks, pipes, plant and storage areas associated with hazardous substances and dangerous goods shall be clearly and appropriately labeled.

Material Safety Data Sheets (MSDSs) shall be handed over for all hazardous substances. The chemical suppliers are responsible for ensuring that their employees shall be trained in using and handling Hazardous Substances. Personal Protective Equipment (PPE) appropriate and necessary for handling hazardous substances shall be provided and used correctly.

The enterprises should workout on-site traffic management plan and communicate to the chemical suppliers. The chemical unloading procedures should also be established and implemented by the chemical supplier's drivers.

10. Project Institutional Arrangements

The Ministry of Industry (Mol) has been empowered by the Government of Thailand with overall responsibility for the implementation of the Montreal Protocol. The National Ozone Unit (NOU), established within Department of Industrial Works of Mol, is responsible for day-to-day operations of the Montreal Protocol Program. A PMU has been established within the NOU for the implementation and day-to-day management of the HCFC Phase-out Management Plan and the related sector plans. PMU will provide technical assistance and assist enterprises to prepare sub-project proposal and conduct monitoring program to ensure the EMP has been implemented.

A sub-grant agreement will be signed between Government Savings Bank (GSB), the financial agent of the project appointed by Ministry of Finance in consultation with Ministry of Industry, and each participating foam enterprise. This legally binding agreement will include the company's HCFC conversion plan and site-specific EMP, which are to be prepared by the applicant enterprise and must be submitted to the PMU for approval. The PMU will monitor compliance with the sub-grant agreement and the site-specific EMP, which is a prerequisite for the release of any grant payment to the participating companies.

Participating companies will report on their HCFC conversion and compliance with the EMP and will furnish required documents according to the monitoring plan indicated in the template of EMP, which will be verified by the PMU. The PMU will record and maintain all information related to the HCFC conversion in participating companies in a secure database.

The World Bank task team will supervise the implementation of the project including its environmental and safety provisions during the project supervision mission. Supervision will include discussion with selected foam enterprises and visits to their production sites.

11. Capacity Building Requirements

It is the responsibility of the participating foam enterprise to select suppliers, contractors and in-house staff and workers, who are trained and capable of following the EMP, the company's SOPs and any applicable environmental protocols and safety provisions, and to supervise their work.

As part of project implementation, the PMU will offer technical workshops for foam enterprises, their staff, suppliers and other stakeholders. These workshops will include sections on HCFC alternatives and their environmental impact (including global warming potential), the installation of new foam blowing equipment, in particular for Cyclo-pentane use, the proper handling of blowing agents and chemicals as well as health, safety and environmental requirements. They will also cover reporting requirements by foam enterprises. In addition, the PMU plans to organize safety trainings for foam production workers in cooperation with chemical and equipment suppliers and local fire protection and environmental authorities.

The technical foam agent consultant to be hired by the PMU will be fully familiar with the HCFC conversion process, including the handling of blowing agents and other chemicals, health and fire hazards and mitigating measures. The PMU and its technical consultant will be available to advise participating foam enterprises if needed.

12. Monitoring of the Project Implementation on Relevant Safeguard Aspects

The monitoring of the project implementation on safeguard aspects should be the responsibility of the Department of Industrial Works and the Institute of Workplace Safety, under the Ministry of Labor and Welfare

PMU and the World Bank will randomly conduct site visits to monitor the safeguard implementation compliance periodically. Project monitoring reports will be provided including any issues encountered during the visits as well as recommendations.

13. Budget

Participating foam enterprises bear the financial responsibility for the conversion of their HCFC-using production facilities to alternative technologies including any environmental mitigation activities required by the EMF/EMP. The project will make an agreed payment to participating foam enterprises, which will cover part of the conversion costs including some environmental and safety measures. The final payment to foam enterprises will only be made after the PMU has confirmed compliance of participating enterprises with all EMF/EMP requirements. The cost of the technical consultant, workshops and trainings organized by the PMU will be borne by the HCFC Phase-out Project.

14. Supporting Documents

The following documents will support the implementation of this EMF:

- Annex A: Brief Description of PU Foam Applications and Baseline Information of PU Production
- Annex B: Detailed of Laws and Regulations for All Foam Enterprises under HPMP Stage I
- Annex C: Detailed of Laws and Regulations for Foam Enterprises Converting to Cyclopentane
- Annex D: Pre-startup Checklist
- Annex E: Template of Environmental Management Plan include monitoring plan
- Annex F: World Bank Environmental, Health and Safety (EHS) Guidelines
- Annex G: Diagram of Existing HCFC-141b Foaming Set and New HFC245fa Foaming Set in Cooled Storage Room and diagram of New Cyclopentane Foaming Set with Storage and Premixing Room
- Annex H: Material Safety Data Sheets
- Annex I: Summary of Project Stakeholder Consultation of Environmental Management Framework for the Foam Sector

ANNEX A Brief Description of PU Foam Applications and Baseline Information of PU Production

A-1: Brief Description of PU Foam Applications

Rigid PU - Box Foam:

There are 4 enterprises participating in this project. Average HCFC 141b consumption is illustrated on the figure 1. Typical large-size polyurethane foam product, varying from 1 x 1 x 1.2 m³ to 3 x 1 x 1.2 m³ (L x W x H). The box foam will then be sliced into thinner piece for further use as insulated panel or as piping insulation. The manufacturing process of box foam companies is simple as the PU foam is the final product. The final product is then slices into pieces prior to sending to the customers. Baseline equipment for the production of box foam is a motor stirrer and mixing vessel, in which Polyol and Isocyanate is mixed before pouring in the cubic mold.

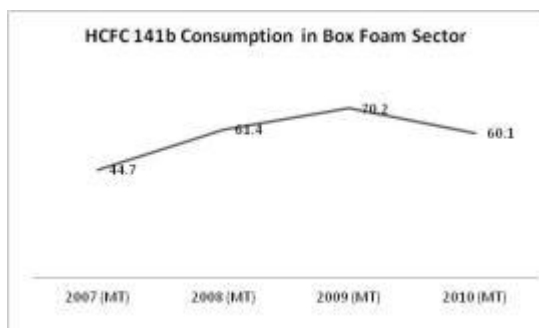
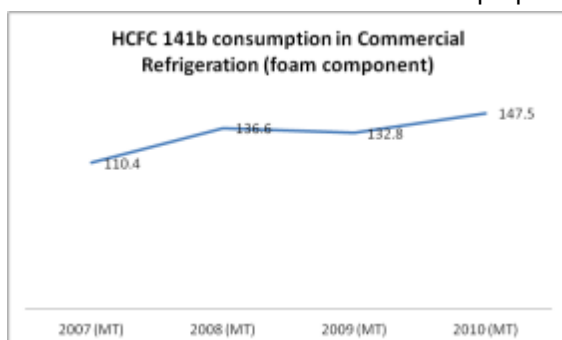


Figure A- 1. HCFC 141 b Consumption in Box Foam

subsector

Rigid PU - Commercial Refrigeration: Products manufactured are panels for commercial refrigerators i.e. display cases and beverage display cabinets. For commercial refrigeration, insulation property of PU Foam is critical component. For this application, there are three main processes; body of the commercial refrigeration, PU foam injection and installation of refrigeration component. PU foam will be injected into the space of the panel of the commercial refrigerator and serve for both insulation and structural purposes.



F



Commercial

Refrigeration subsector.

Rigid PU - Ice Box: Ice box is the largest application of the PU foam sector that is still using HCFC-141b in Thailand. The capacity of ice box varies from about 40 to 800 liters. For this application, there are two main processes; production of box and PU foam injection. The manufacturer has to make the box (commonly made of polyethylene) first and PU foam will be injected into the box to provide insulation property and as cohesive materials. After PU injection, the inner piece of the box will be put on top and pressed to join the outer and inner piece of the box.

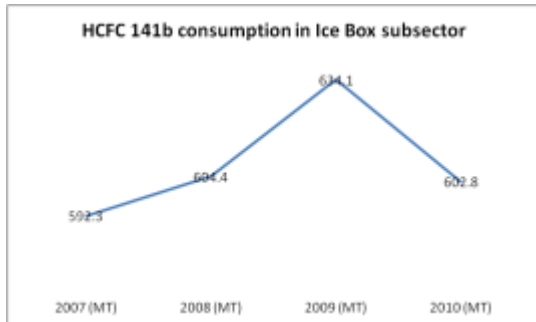


Figure A-3 HCFC 141b consumption in Ice Box subsector

Rigid PU - Refrigerated Truck, Reefer and Fishery Vessel: The use of rigid polyurethane foam in these applications is for both insulation and structural purposes. For this application, there are two main processes; body of the refrigerated truck, reefer and fishery vessel and PU foam injection. PU foam will be injected directly to the structure of the refrigerated truck, reefer and fishery vessel.

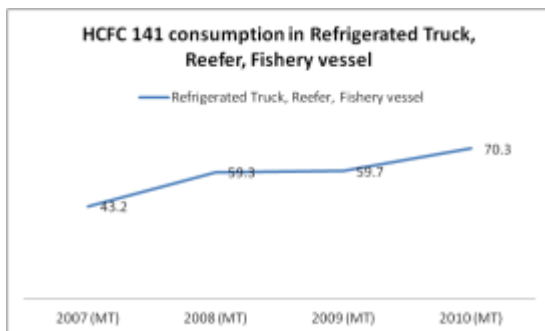


Figure A-4 HCFC 141b consumption in refrigerated trucks, reefer and fishery vessel subsector

Rigid PU - Sandwich Panel, Steel/ Fiber Glass Door: There are two types of sandwich panels; discontinuous sandwich panel for cold rooms, clean rooms and test rooms and continuous roofing panel. The production process of fiber glass door is similar to discontinuous sandwich panel. For discontinuous sandwich panel, there are two main processes; body of the panel and PU foam injection. PU foam will be injected directly to the structure of the panel for both insulation and structural purposes. After PU injection, the press will be applied to the injected products. For continuous panel, there is need for foam injection machine to allow the manufacturer of continuous process.

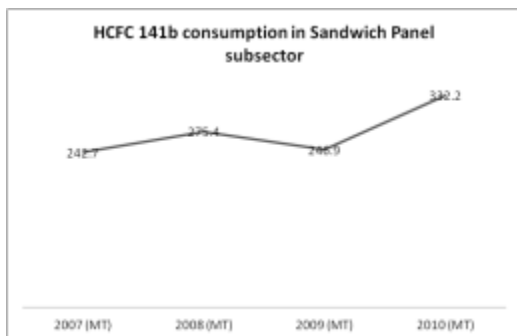


Figure A-4 HCFC 141b consumption in sandwich panel, steel/fiber glass door subsector

Rigid PU - Thermoware: The production process of thermoware (i.e. thermos bottle) is similar to that of ice box. The capacity of thermoware is smaller than the ice box. For this application, there are two main processes; production of thermos bottle and PU foam injection. The manufacturer has to make the thermos bottle first and PU foam will be injected into the bottle to provide insulation property and as cohesive materials. After PU injection, the inner piece of the bottle will be put on top and pressed to join the outer and inner piece of the bottle.

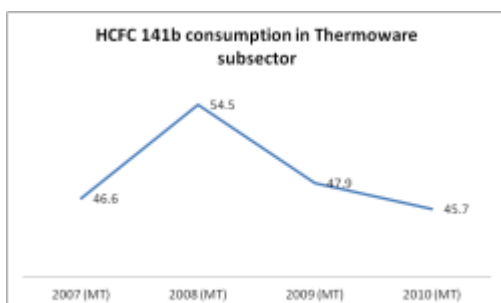


Figure A-4 HCFC 141b consumption in thermoware subsector

Rigid PU - Pipe Section and Wood Imitation: The manufacturing process of pipe section and wood imitation is simple as the PU foam is the final product. The companies have various sizes of molds and PU foam will be injected into the mold.

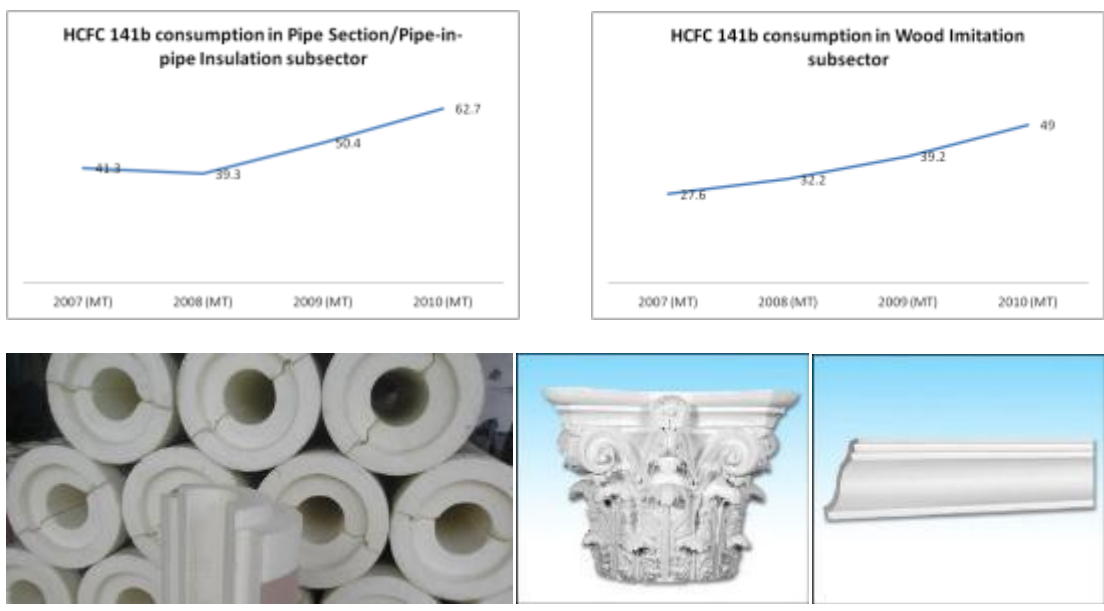


Figure A-4 HCFC 141b consumption in pipe- section and wood imitation subsector.

Flexible PU: The remaining application of flexible PU foam that still use HCFC-141b is flexible molded foam for saddle and seating. The manufacturing process is simple as the PU foam is the final product. The companies have various sizes of molds and PU foam will be injected into the mold.

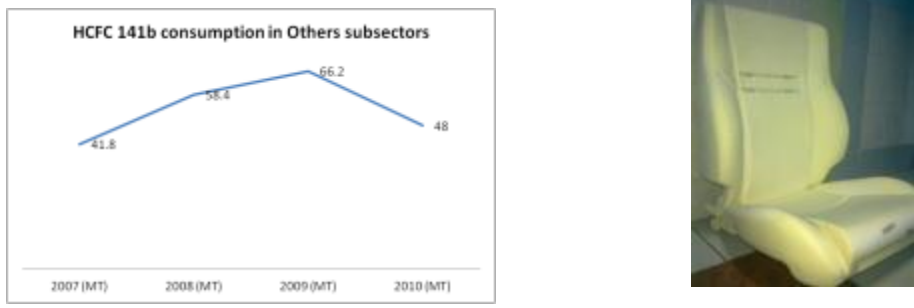


Figure A-4 HCFC 141b consumption in other flexible foam application subsector

Integral Skin Foam: The remaining application of integral skin foam that still use HCFC-141b is automotive parts and shoe sole industries. The manufacturing process is simple as the PU foam is the final product. The companies have various sizes of molds and PU foam will be injected into the mold.



Figure A-4 HCFC 141b consumption in integral skin foam subsector

A-2: Baseline Information of PU Production

The main chemicals used for the production of PU foam (rigid PU foam, flexible PU foam and integral skin foam) are Polyol and MDI (Isocyanate), which will be mixed with different formulation according to the system's recommendation.

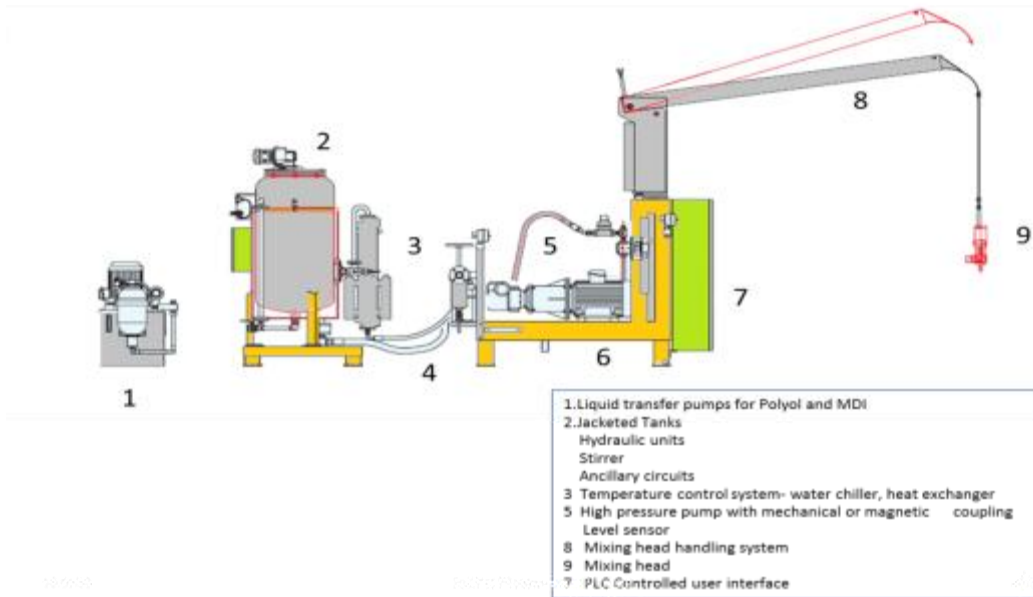
Polyol can be either:

- Pure Polyol: Pure Polyol is Polyol that does not have composition of blowing agent, but will be mixed with blowing agent at the site of the enterprises. In this case, the enterprises normally have a unit call pre-mixing unit that homogenizes blowing agent and pure Polyol. Under HPMP Stage I, the use of pure Polyol is account for approximately 10% of the total usage.
- Pre-blended Polyol: Pre-blended Polyol is Polyol that have already contained blowing agent when supplying to the enterprise. Under HPMP Stage I, the use of HCFC-141b pre-blended Polyol is predominated and account for approximately 90% of the total usage.

Polyol (already mixed with blowing agent) will mix with Isocyanate to produce PU foam. There are two common practices to mix Polyol with Isocyanate as follows:

- Foam injection machine: There are two types of foam injection machines; high pressure and low pressure foam injection machines. The foam injection machine will draw Polyol and Isocyanate from the two separate tanks. The Polyol will mix with Isocyanate at the mixing head before injecting mixed liquid PU foam into the mold. In some design especially mobile foam injection machine for spray foam, the foam injection machine will draw Polyol and Isocyanate directly from the drum.
- Hand-mixing: The hand-mixing method means the use of motor stirrer to mix Polyol and Isocyanate in the container. After mixing, the worker will pour liquid PU foam into the mold.

Common equipment in foam blowing process



Common equipment in foam blowing process at medium size factory are;

- Liquid transfer pumps for Polyol and MDI
- Jacketed Tanks
- Hydraulic units
- Stirrer
- Ancillary circuits
- Temperature control system- water chiller, heat exchanger
- High pressure pump with mechanical or magnetic coupling
- Level sensor
- Mixing head handling system
- Mixing head
- PLC Controlled user interface



Photo-A-1 Top- Working condition manual mixing station. A portable electrical powered grinder which has been used for stirring the mixture before pouring into the mold.

Bottom- A worker was manually scraping the mixture of foam.

ANNEX B Detailed of Laws and Regulations for All Foam Enterprises under HPMP Stage I

Table B-1 Summary of laws and regulations pertaining to foam enterprises

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
Workplace, building and Structure Safety and Fire Protection	Factory Act B.E. 2535 by Ministry of Industry	<p>Section 1 clause 18(2) of Factory Act B.E. 2535</p> <p>Section 8: For the purpose of control of the engagement in a factory business, the Minister shall have the power to prescribe the ministerial rules with which any or all groups of factory under Section 7 must comply with respect to the following matters.</p> <ol style="list-style-type: none"> (1) To adopt the criteria relating to the location of factory, environment of the factory, nature of the buildings of factory, or interior nature of the factory. (2) To adopt the nature, type, or kind of machines, equipment or such other things as to be used for the engagement in a factory business. (3) To adopt the requirements of specialized workers according to the type kind, or size of factory to perform duty for such factory. (4) To adopt the criteria to be followed, process of production and provision of other equipment or tools in order to prevent or stop or mitigate the dangers, injuries, or troubles that may cause to the persons or property in the factory or its vicinity. (5) To adopt the standards and methods of controlling the discharge of wastes, pollutants or anything that affects the environment as a result of the engagement in a factory business. (6) To adopt the provision of required documents for the factory for the purpose of controlling and inspection the compliances with the laws. (7) To adopt the required information relating to the engagement in a factory business of which a person engaging in a factory business must inform, from time to time or in a specified period. (8) To adopt any other requirements for the protection of safety in the operations in order to prevent or stop or mitigate the dangers or injuries that may result from the

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>engagement in a factory business.</p> <p>Section 12: A person engaging in a factory business of group 3 must obtain a permit from the Grantor and must comply with the criteria provided for in the ministerial rules prescribed pursuant to Section 8, the Notification of the Minister prescribed pursuant to the said ministerial rules and the Notification of the Minister prescribed pursuant to Section 32.</p> <p>Section 18: A recipient of a permit may not expand the factory unless permitted by the authority.</p> <p>Section 12, Section 13, and Section 16 shall apply mutatis mutandis to the application for expansion of the factory and the grant thereof including the appeal of the order refusing such expansion.</p>
	<p>Notification of the Ministry of Industrial Subject: Factory Fire Prevention and Control B.E. 2552</p>	<p>Section 2: Fire Alarm System Especially the area that none of employee works, electrical installation and using area, Flammable or combustible materials including detection system and automatic fire alarm system. The Fire Alarm System has to be electrical backup system at least 2 hours that should be separate with electrical supply to normal lighting and machine.</p> <p>Section 3: Fire Extinguisher 7) The tare weight of fire extinguisher at least 4.5 k.g. and ready to extinguish fire at any time, inspection period at least 6 months. 9) Distance between each of fire extinguisher is less than 20 meters and the top height from ground floor level at least 1.50 meter including safety sign, non-obstruct materials and easy access and egress to reach the fire extinguisher.</p> <p>Section 4: Fire Water System 10) Prepare fire water for supply to firefighting equipment at least 30 minutes.</p> <p>Section 5: Automatic Fire Extinguisher System 12) Combustible Raw materials or product storage area at least 1,000 m², this storage area is required automatic fire extinguisher system installation i.e. automatic sprinkler system, or any equalization system that covered this storage area. 14) Flammable materials storage area at least 14 m², this storage area is required automatic fire extinguisher system installation, that has to be suitable with the condition at this storage area.</p> <p>Section 6: Inspections and Preventive Maintenance 15) Inspections and preventive maintenance program is in place, the requirement as of this Notification of the Ministry of Industrial.</p> <p>Section 7: Fire Prevention and Control training 17) Provide fire prevention and control training for employees and records keeping</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>Section 8: others</p> <p>18) Opening walls, floors, beams and pipe penetration shall be seal with fire resistance materials that has minimum fire resistance for 2 hours.</p> <p>19) Combustible raw materials, products or flammable materials storage area has to be isolated with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>20) One storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>Many storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 2 hour.</p> <p>21) Hot work permit system has to be implemented.</p> <p>22) Provide fire evacuation route to evacuate all employees to safe location at least 5 minutes.</p> <p>23) Combustible materials storage which are not storage on the pallet rack should not be stack higher than 6 meters and keep the distance of the top layer to the lamp on the roof at least 60 c.m.</p> <p>24) Machine, equipment, storage tanks, reactor or any process that containing with flammable substance shall be bonded and grounded for electro-static discharge.</p> <p>25) Flammable substance storage handling shall be complied with the guidance provide on Safety Data Sheet.</p> <p>26) Assign the employee to be safety responsible person of factory and conduct fire safety inspections at least monthly.</p> <p>27) Provide fire prevention and control plan including fire safety inspections plan, fire prevention and control plan and fire evacuation plan.</p>
	<p>Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Fire Prevention and Control B.E. 2555</p>	<p>Section 1: General</p> <p>2) Provide Fire Prevention and Control System within an effety and safely condition.</p> <p>3) Provide the fire protection equipment and evacuation route signs.</p> <p>4) Fire Prevention and Control Plan is implemented; including inspection, training, promotion, prevention, control, evacuate and recovery.</p> <p>6) Conduct Standards Operating Procedure (SOP) prior fire risk task will be assigned.</p> <p>7) - Combustible materials shall separate storage area. - Absorb water materials shall storage at the ground floor.</p> <p>Section 2: Building and Fire Evacuation Route Safety</p> <p>Section 3: Extinguish Fire</p> <p>Section 4: Fire Protection from Heat Radiation</p> <p>Section 5: Flammable and Explosive Materials</p> <p>Section 6: Combustible or Flammable Waste Disposal</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>Section 7: Lightning Hazard Prevention Section 8: Fire Safety Implementation and Reporting 27) Conduct Basic Fire Fighting at least 40% of the total number of employees by authorized training center approval from Welfare and Labor Protections Department 28) Fire Prevention Implementation. 1. Fire prevention and control management team and director, shall be available at any time while operating activities. 2. Conduct fire prevention and control, fire extinguish equipment usage, first aid and rescue training for fire prevention and control personnel. 29) All Employees shall involve on Evacuation Exercise at least annually</p>
	<p>Notification of the Ministry of Welfare and Labor Protection Subject: Portable Fire Extinguisher Standards B.E. 2556</p>	<p>2) Portable Fire Extinguisher Standards B.E. 2556 refers to National Fire Protection Association (NFPA), American National Standards Institute (ANSI), Australia Standards (AS), British Standard (BS) and International Standardization and Organization (ISO)</p>
<p>Plant Equipment, Machineries Safety</p>	<p>Factory Act B.E. 2535 by Ministry of Industry</p>	<p>Section 1: clause 18(2) of Factory Act B.E. 2535 Section 8: For the purpose of control of the engagement in a factory business, the Minister shall have the power to prescribe the ministerial rules with which any or all groups of factory under Section 7 must comply with respect to the following matters. (1) To adopt the criteria relating to the location of factory, environment of the factory, nature of the buildings of factory, or interior nature of the factory. (2) To adopt the nature, type, or kind of machines, equipment or such other things as to be used for the engagement in a factory business. (3) To adopt the requirements of specialized workers according to the type kind, or size of factory to perform duty for such factory. (4) To adopt the criteria to be followed, process of production and provision of other equipment or tools in order to prevent or stop or mitigate the dangers, injuries, or troubles that may cause to the persons or property in the factory or its vicinity. (5) To adopt the standards and methods of controlling the discharge of wastes, pollutants or anything that affects the environment as a result of the engagement in a factory business. (6) To adopt the provision of required documents for the factory for the purpose of controlling and inspection the compliances with the laws. (7) To adopt the required information relating to the engagement in a factory business of which a person engaging in a factory business must inform, from time to time or in a specified period.</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>(8) To adopt any other requirements for the protection of safety in the operations in order to prevent or stop or mitigate the dangers or injuries that may result from the engagement in a factory business.</p> <p>Section 12: A person engaging in a factory business of group 3 must obtain a permit from the Grantor and must comply with the criteria provided for in the ministerial rules prescribed pursuant to Section 8, the Notification of the Minister prescribed pursuant to the said ministerial rules and the Notification of the Minister prescribed pursuant to Section 32.</p> <p>Section 18: A recipient of a permit may not expand the factory unless permitted by the Grantor.</p> <p>Section 12, Section 13, and Section 16 shall apply mutatis mutandis to the application for expansion of the factory and the grant thereof including the appeal of the order refusing such expansion.</p>
	Occupational Safety, Health and Environment Act B.E. 2554 by Ministry of Labor and Welfare	<p>Section 16: An Employer shall provide an occupational safety, health and environment training to be attended by an Executive, a Supervisor and an Employee in order to safely administer, manage and operate the occupational safety, health and environment.</p> <p>Whereas the Employer employs an Employee to work, changes work, changes workplace or changes machinery or equipment that may be harmful to life, physique, mentality and health of the Employee, the Employer shall provide training for every Employee before commencing work. The training under paragraph one and paragraph two shall be in conformity with criteria, methods or terms as stipulated by the Director-General.</p> <p>Section 19: Whereas an Employer rents a building, premise, tool, machinery, equipment or any others to be used in an establishment, the Employer shall have powers to carry out an operation on occupational safety, health and environment involving with the rend building, premise, tool, machinery, equipment or any others in accordance with the standards as prescribed in the Ministerial Regulation issued under Section 8.</p> <p>Chapter 2: Administration, Management and Operation on Occupational Safety, Health and Environment</p> <p>Section 8: An Employer is required to administer, manage and operate the occupational safety, health and environment in conformity with the standards prescribed in the Ministerial Regulation.</p> <p>In setting the standards under paragraph one, the Employer shall provide document or report examined or certified by person or juristic person as prescribed in the Ministerial Regulation.</p> <p>An Employee is obligated to comply with criteria on occupational safety; health and</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		environment in accordance with the standards prescribed in paragraph one.
		<p>Chapter 4: Control, Supervision and Administration Section 32: For the purpose of control, supervision and administration operations on occupational safety, health and environment, an employer shall perform as follows: (1) To conduct hazard assessment; (2) To conduct study on impacts of working conditions which have an effect on employee; (3) To prepare operation plan on occupational safety, health and environment and supervisory plan for employee and the establishment (4) To submit results on hazard assessment, impact study, operation plan and supervisory plan under (1), (2) and (3) to the Director-General or a person entrusted by the Director- General. Criteria, methods and conditions on performance under paragraph one, type of business, size of business required to be operated and operation period shall be as per prescribed by the Minister published in the Government Gazette. In performing the work under paragraph one, the employer shall comply with recommendations of and results shall have been certified by the expert on occupational safety, health and environment. Section 36: Whereas a Safety Inspector has found that an Employer, an Employee or any concerned person has violated or failed to comply with this Act or the Ministerial Regulation issued under this Act or has found that the working conditions, buildings, premises, machinery or equipment used by the Employee may be dangerous to the Employee, the Safety Inspector shall have the power to order such person to stop such violating acts or to correct, improve or conform correctly or properly within thirty days. If there is necessary cause which prevents such operation to be able to be completed within such period, the Safety Inspector may extend such period not more than twice, each with thirty days from the due date of such period. In case it is necessary, upon permission of the Director-General or a person entrusted by the Director-General, the Safety Inspector shall have the power to order to stop the usage of machinery or equipment, building, premise or to bind and stamp on material which may cause severe danger to such Employee, in whole or in part, during the compliance with the order of the Safety Inspector. When the Employer has corrected and improved to conform correctly to order of Safety Inspector under paragraph one, the Employer shall inform the Director-General or person entrusted by the Director-General for the consideration on revocation of such order.</p>
	Ministerial Regulation of Occupation Safety, Health and Environmental	Section 1: Machineries Sub-section 1: General Sub-section 2: Metal Pressed Machineries Sub-section 3: Electrical and Gases Welding Machineries

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
	Standards for Machinery, Crane and Boiler B.E. 2552	Sub-section 4: Forklift Trucks Sub-section 5: Elevators Section 2: Cranes Sub-section 1: General Sub-section 2: Overhead Cranes and Tower Cranes Sub-section 5: Crane Equipment and Devices Section 4: Personal Protective Equipment
Electrical System	Ministerial Regulation of Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554	Section 1: General Section 2: Electrical Apparatus Section 3: Lightning Protection Section 4: Personal Protective Equipment and Safety Devices or Equipment for Prevention electrical hazards
Health and Hygiene	Ministerial Regulation on the Prescribing of Criteria and Method of Conducting Health Checkup of Employees and Forwarding the results of health checkup to labor inspector B.E. 2547(A.D.2004) by Ministry of Labor and Welfare	Clause 2: In this Ministerial Regulation “Health Checkup” means the physical and mental states checkup according to medical method as to ascertain the suitability of and the work-related effects on health of the employees. “Risk-factor-related work” means the work which the employee performs in relation to: (1) Hazardous chemical substances as prescribed in the Announced of the Minister. (2) Toxic microbe which may be a virus, bacteria, fungus or other biological organisms as prescribed in the Announced of the Minister. (3) Radioactivity (4) Heat, cold, vibration, atmospheric pressure, light, noise or other environments which may be hazardous; for this purpose, as prescribed in the Announced of the Minister. Chapter 1: Health Checkup Clause 3: For the employees who work with risk factors, the employer shall provide health checkup to be conducted by a licensed medical practitioner who is specialized in occupational medicine; or who has undergone a training on occupational medicine; or who possesses the qualifications as prescribed in the Notification by the Director-General by completing the first health checkup for employees within thirty days from the first day the employee is employed; and the subsequent health checkup shall be conducted at least once a year. In case the characteristics or the condition of work is related to risk factors and needs health checkup in different period of time, the employer shall avail health checkup for the employees according to such period. In case the employer changes the employee’s dangerous job to be a different one, the employer shall provide health checkup for such employees within thirty days from the date of the job change.

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>Clause 4: In case the employee is absent from work for consecutive three days due to accident or illness irrespective of circumstance, the employer may request medical explanation from the physician who conducts treatment, or from the physician attached to the establishment, or provide health checkup for the employee before allowing the employee to resume the work.</p> <p>Chapter 2: Recording, Reporting and Forwarding the Results of Health Checkup</p> <p>Clause 5: For the purpose of health checkup of the employee pursuant to Clause 3, the medical practitioner who conducts a health checkup shall record the details of the results of health check up by indicating the practitioner's explanation about health condition of the employee that may affect, or pose obstacles to the work or to the characteristics of the Employee's assigned work; together with the signature of the practitioner who gives treatment and medical explanation on the date of the check up or of giving such medical explanation.</p> <p>Clause 6: The employer shall provide personal Health Report Book of the employee who is working with the risk factors according to the format prescribed in the Notification by the Director-General; and the employer shall record the results of every health check up in the employee's Health Report Book.</p> <p>Clause 7: The employer shall keep the records of employee's health checkup pursuant to Clause 3 including relevant information to be ready for inspection by a labor inspector at all times. The record of each employee shall be kept at the employer's office for not less than two years as from the date of employment termination, unless there is a complaint that the employer has not complied with the law; or there is a lawsuit in relation to any disease or any hazard to the employee's health. In that case, even though the specified time has expired, the employer shall be required to keep such document until the final judgment concerning the said matter is settled. In this regard, the employer shall not be permitted to use such information in the way that is unreasonably detrimental to the employee.</p> <p>Clause 8: The employer shall inform the result of health check up to the employee as follows: (1) In case the health checkup result is not normal, the employee shall be informed within three days from the date of acknowledgement of the result; (2) In case the health checkup result is normal, such employee shall be informed within seven days from the date of acknowledgement of the result;</p> <p>Clause 9: In case of such abnormality of the employee is detected; or the employee is developing a symptom or illness relating to work, the employer shall arrange for the employee to receive medical treatment immediately; and further carry out an inspection or find out the cause of abnormality for prevention purposes. The employer shall forward the results of the health checkup of the employee whose abnormality or illness has been detected; whose medical treatment and prevention or remedy has been provided; to the labor inspector</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>according to the format prescribed by the Director-General within thirty days as from the date of acknowledgement of the abnormality or illness.</p> <p>Clause 10: If any employee has medical evidence from the government hospital or the hospital recognized by the government showing that the employee shall not be able to perform work in the same duty, the employer shall proceed to change such job for the employee as to the importance of employee's health and safety.</p> <p>Clause 11: The employer shall give the personal Health Report Book to the employee upon termination of employment.</p>
Emergency Preparedness and Response	<p>Notification of the Ministry of Industrial</p> <p>Subject: Factory Fire Prevention and Control B.E. 2552</p>	<p>Section 2: Fire Alarm System Especially the area that none of employee works, electrical installation and using area, Flammable or combustible materials including detection system and automatic fire alarm system. The Fire Alarm System has to be electrical backup system at least 2 hours, which should be separate with electrical supply to normal lighting and machine.</p> <p>Section 3: Fire Extinguisher 7) The tare weight of fire extinguisher at least 4.5 k.g. and ready to extinguish fire at any time, inspection period at least 6 months. 9) Distance between each of fire extinguisher is less than 20 meters and the top height from ground floor level at least 1.50 meter including safety sign, non-obstruct materials and easy access and egress to reach the fire extinguisher.</p> <p>Section 4: Fire Water System 10) Prepare fire water for supply to firefighting equipment at least 30 minutes.</p> <p>Section 5: Automatic Fire Extinguisher System 12) Combustible Raw materials or product storage area at least 1,000 m², this storage area is required automatic fire extinguisher system installation i.e. automatic sprinkler system, or any equalization system that covered this storage area. 14) Flammable materials storage area at least 14 m², this storage area is required automatic fire extinguisher system installation, that has to be suitable with the condition at this storage area.</p> <p>Section 6: Inspections and Preventive Maintenance 15) Inspections and preventive maintenance program is in place, the requirement as of this Notification of the Ministry of Industrial.</p> <p>Section 7: Fire Prevention and Control training 17) Provide fire prevention and control training for employees and records keeping</p> <p>Section 8: others</p>

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
		<p>18) Opening walls, floors, beams and pipe penetration shall be seal with fire resistance materials that has minimum fire resistance for 2 hours.</p> <p>19) Combustible raw materials, products or flammable materials storage area has to be isolated with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>20) One storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 1 hour.</p> <p>Many storey building with the metal structure has to be covered with fire a resistance material that has minimum fire resistance for 2 hour.</p> <p>21) Hot work permit system has to be implemented.</p> <p>22) Provide fire evacuation route to evacuate all employees to safe location at least 5 minutes.</p> <p>23) Combustible materials storage which are not storage on the pallet rack should not be stack higher than 6 meters and keep the distance of the top layer to the lamp on the roof at least 60 c.m.</p> <p>24) Machine, equipment, storage tanks, reactor or any process that containing with flammable substance shall be bonded and grounded for electro-static discharge.</p> <p>25) Flammable substance storage handling shall be complied with the guidance provide on Safety Data Sheet.</p> <p>26) Assign the employee to be safety responsible person of factory and conduct fire safety inspections at least monthly.</p> <p>27) Provide fire prevention and control plan including fire safety inspections plan, fire prevention and control plan and fire evacuation plan.</p>
Discharge, Emission and Waste Management	Notification of the Ministry of Industry number 2 subject: Characteristic of Waste Water Discharged from Factory B.E. 2539	The Characteristic of Waste Water Discharged from Factory has been defined in Notification of the Ministry of Industry number 2
	Notification of the Ministry of Industry subject: Waste or Unused Materials Management B.E. 2548	The Waste or Unused Materials Management has been implemented referred to Waste or Unused Materials Management B.E. 2548.
	Notification of the Ministry of Industry subject : Hazardous Waste Manifest Transport Documentation System B.E. 2547	The Hazardous Waste disposal transportation acuties has been implemented the Hazardous Waste Manifest Transport documentation system refer to Notification of the Ministry of Industry subject: Hazardous Waste Manifest Transport Documentation System B.E. 2547.
	Notification of the Ministry	If any factory has waste water system, that factory shall provide devices or special devices

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
	of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices (number 1) B.E. 2547	refer to Waste Water System of Factory shall be installed devices or specials devices (number 1) B.E. 2547
	Notification of the Ministry of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 2) B.E. 2548	If any factory has waste water system, that factory shall provide devices or special devices or additional devices refer to Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 2) B.E. 2548
	Notification of the Ministry of Industry Subject: Waste Water System of Factory shall be installed devices or specials devices or additional devices (number 3) B.E. 2549	Expand installation due date to be 31st December B.E. 2551
	Notification of the Ministry of Industry Subject: Defined quantity of air emission from the factory B.E. 2549	“Air emission” means any air that vent from stack or chimney vent duct from factory that is passed from air emission treatment system or not refer to Notification of the Ministry of Industry, Subject: Defined quantity of air emission from the factory B.E. 2549
	Notification of the Ministry of Industry Subject: Provide types and quantities of pollutant that has been vented or drained from factory B.E. 2550	Waste water drainage system and air emission from the factory has been report the types and quantities to Ministry of Industry refer to Notification of the Ministry of Industry Subject: Provide types and quantities of pollutant that has been vented or drained from factory B.E. 2550
	Notification of the Ministry of Natural Resources and Environment	“Manufacturing Factory” means the classified as Group 2 and Group 3 factory refers to Factory Act B. E. 2535

Concerned Processes/Chemicals	Name of Laws / Regulations	Brief Description of Laws / Regulations
	Subject: Define the standards control of air emission from factory	

ANNEX C Summary of Safety Criteria for storage area for Cyclo-pentane

The following guidelines has been developed and announced by the Department of Industrial Works, which is available for download at the website:

<http://eis.diw.go.th/haz/hazard/pdf/pagad-kep-2550.pdf>

This guideline should be applied for the foam manufacturing company who are seeking for instruction to make the storage facility for Cyclo-pentane in their facility safe.

Table C-1 Guidelines should be applied for the air conditioner manufacturing company for storage facility for HFC-32 and other compressed gases and chemicals.

Structures	Guidelines
Building wall, compartment and fire wall	<p>Wall/ compartment must be fire resistant material. Width and height of the fire wall has been defined by this guideline (Section 2.1: Storage Facility)</p> <p>The foam factory plant who plan to build new storage room for flammable hydrocarbon and others flammable chemicals must be aware that the new building which is located near the other building in 10 meter distance, the wall and compartment must be capable of fire resistant for at least 3 hours.</p>
Floor	Specific requirement for the floor of storage room is conductive floor to prevent electro static charge.
Doors ways and emergency exit	The storage room must have at least 2 doors for entrance and exit. The size of the door must meet design criteria. Emergency light, safety signs are required.
Roof	Fire resistant more than 30 minutes
Ventilation system	Required and must meet specified criteria.
Electrical system	<p>Meet Engineering design criteria specified by the Thailand Engineering Association.</p> <p>storage room requires to meet EX-Proof type and electrostatic charge protection, grounding</p>
Emergency lighting	Required at least at doors and exit.
Electrical appliances	storage room requires to meet EX-Proof type and electrostatic charge protection, grounding
Lightning protection	Building near the storage room in the distance 30 meter must have lightning system. The design must meet Engineering design criteria specified by the Thailand Engineering Association.

Structures	Guidelines
Detection and alarm system	Detection and alarm system is required
Fire protection system	Fire extinguishers, portable or fixed system
Fire water	Must have adequate fire water based on the size of storage facility.

ANNEX D Pre-startup Checklist

Factory/Location

Inspected by

Reviewed by

Inspection date

REQUIREMENTS	Compliance with requirements		COMMENTS /ACTIONS
	Y	N	
1. No sign of leak or spill			
2. Spill kits available, ready for use			
3. Safety signs are clearly visible, readable			
4. Housekeeping is well maintained			
5. SOP is posted, no ignition sources is allowed			
6. Fenced in with locked door (storage room)			
7. Secondary containment is adequate size, no crack or leak, no rain water in side.			
8. Electrical installation meeting codes			
9. Gas sensor installed and operational			
10. PPE is available and used			

REQUIREMENTS	Compliance with requirements		COMMENTS /ACTIONS
	Y	N	
<p>11. Leak detection installed (Only required for underground tanks)</p> <p>This device is designed for the detection of leakage from underground flammable liquid pipeline systems by directly or indirectly measuring changes in the volume or pressure of the liquid in the system over a period of time.</p>			
<p>12. Two 9 kg ABC portable fire extinguishers</p> <p>Using 9 kg ABC fire extinguishers to fight a small fire on flammable liquid is safer than using many small fire extinguishers because of more coverage of the dry chemical powder. Fire can flash back if the dry powder is not sufficient.</p>			
<p>13. Connection to the pre-mixer meeting requirements</p>			
<p>14. Grounded, with extra cable to connect to drums or tank truck when flammable liquid to be transferred. Bonding cable between each element of Foam equipment must be connected.</p>			
<p>15. Gas detection and alarm system are functioning/ tested and recorded</p>			
<p>16. Water hydrant readily available</p>			
<p>17. All concerned workers are well trained</p>			

ANNEX E Template of Environment Plan and Monitoring Plan

The preparation of an EMP is a project requirement for foam sector enterprises that convert their foam production to the use of Cyclo-pentane as blowing agent. Enterprises that convert to HFC-245fa or water blown technology do not need to prepare an EMP, but are required to update and follow their Standard Operating Procedures (SOP), which will be verified by the PMU.

Prospective project beneficiaries may prepare an EMP by completing the template below and submitting it together with their project application and conversion plan to the PMU for approval and inclusion in the Sub-grant Agreement.

The EMP is designed to ensure that mitigation measures are implemented and have the intended results. Additional remedial measures must also be indicated in the EMP and be carried out if the mitigation measures identified below are inadequate or the impacts have been underestimated.

Instructions:

The EMP template below contains a section on general information and two checklists: checklist 1 shall be used for "Cyclo-pentane delivered by tank trucks and stored in tanks" and checklist 2 for "Cyclo-pentane delivered in drums".

Please complete the general information section and submit it to the PMU along with the checklist that applies to your situation. If necessary, please provide additional information, details and background documents (drawings, technical specifications) as attachment.

During or promptly after the conversion process, the checklist must be completed by the manager appointed to oversee the conversion (date / signature confirming compliance) and, once completed, the original checklist must be sent to the PMU.

Acronyms:

CP – Cyclo-pentane

Ex – explosive / explosion

EMP Template – General information

Name of company:		
Address:		
Contact person:		Tel:
		Email:
Location:	Mixed residential and commercial area	
	Commercial zone	
	Industrial zone	
Number of employee		

Brief description of the company and its production:

--

Baseline information:

Foaming equipment	Unit 1:					
	Unit 2:					
HCFC-141b consumption	2010		2011:		2012:	

Environmental and health characteristic of the alternative selected

Parameter	Values	Risk identified	Measures proposed

Approvals by relevant authorities

Authorities	Item/	Date
	Storage of Cyclo-pentane. Max CP Amount	
	Fire safety plan	

Attachments

Map showing location of factory and surroundings	Annex
Floor plan foam production area	Annex
Plan showing location of CP storage area/tank	Annex
Standard Operating Procedures (SOP) after conversion	Annex (for information)

Proposed safety measure for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank

Components / area	National requirements	Safety measures
CP storage tank above or underground	<p>National requirement for storage of CP.</p> <p>DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550</p> <p>The Notification of Ministry of Finance Subject Defined characteristic of Hydrocarbon Solvent B.E. 2552</p> <p>The Procedure for inspection the enterprises who are the suppliers of hydrocarbon solvents, and the inspection at the facility of the users of hydrocarbon solvents for industrial purposes B.E. 2554</p> <p>Ministerial Regulation Construction of other type of structure that is classified as a building under Building laws B.E.2544</p> <p>(Issued by Ministry of Interior) Item (1) A construction of the following structures are to be regulated by the Building Act B.E. 2522;</p>	<p>CP storage tank located outside the building, and Protected against direct exposure to sunlight.</p>
	<p>Minimum distance to boundary of the property, to the factory and other buildings.</p>	<p>Location of CP storage tank approved by relevant authority.</p>
	<p>Access road for delivery of CP.</p>	<p>Easy access and exits for trucks delivering CP.</p>
	<p>Electrical code normally includes requirements regarding electrical installation in areas where explosive gases can occur.</p>	<p>Electrical installation in CP tank area in accordance with Thailand Electrical Code.</p>
		<p>CP gas detectors installed.</p>
		<p>Fence around the CP storage area.</p>
		<p>Safety marking and signs.</p>
CP Pre-mixing unit	<p>As per the foam equipment supplier specifications.</p>	<p>See supplier specifications regarding safety measures. (Safety measures are normally part of the pre-mixing unit package.)</p>
Foaming area and jigs	<p>As per recommendation by MLF and Foam equipment supplier.</p>	<p>HP foaming equipment designed for the use CP (ex-proof electrical installation and wiring).</p>
		<p>Electrical installations in the area consistent with ex-area classification.</p>
		<p>Grounding of foaming equipment and jigs.</p>

Components / area	National requirements	Safety measures
		Ventilation system with design capacity (m ³ /h) as specified by equipment supplier installed. CP Gas Detection System installed. CP Gas detectors installed. Nitrogen system installed. Firefighting equipment installed.
Awareness and training	Involve local fire authority.	General awareness. Training of workers.

Proposed safety measure for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank (Continue)

Components / area	National requirements	Safety measures
Operational manual for workers involved in handling CP foaming	Supplier of foaming and safety equipment.	Training of workers involved in foaming.
		Use of spark free tools in areas with risk of CP.
Checking and maintenance of safety measures	Recommended practice by foam equipment supplier and suppliers of fire safety equipment and relevant safety authorities.	Develop a daily, monthly quarterly and annual program for checking and reporting.
Emergency plan	Prepared in cooperation with suppliers and local safety authorities.	Develop an emergency plan by internal team and with advice from local fire safety authorities.

Check list of safety measure for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank

Components / area	National requirements	Safety measures	Complied / Implemented
CP storage tank above or underground	National requirement for storage of CP.	CP storage tank located outside the building, and Protected against direct exposure to sunlight.	
	Minimum distance to boundary of the property, to the factory and other buildings.	Location of CP storage tank approved by relevant authority.	
	Access road for delivery of CP.	Easy access and exits for trucks delivering CP.	
	Electrical code normally includes requirements regarding electrical installation in areas where explosive gases can occur.	Electrical installation in CP tank area in accordance with Indonesian Electrical Code.	
		CP gas detectors installed.	
		Fence around the CP storage area.	
		Safety marking and signs.	
CP Pre-mixing unit	As per the foam equipment supplier specifications.	See supplier specifications regarding safety measures. (Safety measures are normally part of the pre-mixing unit package.)	
Foaming area and jigs	As per recommendation by MLF and Foam equipment supplier.	HP foaming equipment designed for the use CP (ex-proof electrical installation and wiring).	
		Electrical installations in the area consistent with ex-area classification.	
		Grounding of foaming equipment and jigs.	
		Ventilation system with design capacity (m ³ /h) as specified by equipment supplier installed.	
		CP Gas Detection System installed.	
		CP Gas detectors installed.	
		Nitrogen system installed.	
		Firefighting equipment installed.	

Check list of safety measure for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank (Continue)

Components / area	National requirements	Safety measures	Complied / Implemented
Awareness and training	Involve local fire authority.	General awareness. Training of workers.	
Operational manual for workers involved in handling CP foaming	Supplier of foaming and safety equipment.	Training of workers involved in foaming.	
		Use of spark free tools in areas with risk of CP.	
Checking and maintenance of safety measures	Recommended practice by foam equipment supplier and suppliers of fire safety equipment and relevant safety authorities.	Develop a daily, monthly quarterly and annual program for checking and reporting.	
Emergency plan	Prepared in cooperation with suppliers and local safety authorities.	Develop an emergency plan by internal team and with advice from local fire safety authorities.	

Environment Monitoring Plan for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank

Indicators	Schedule	Responsible party/person
Accident statistics and reporting	Once a year	Safety officer of enterprises
Fire drill/emergency drill records	Once a year	Safety officer of enterprises
Waste disposal record for conversion process indicating type and quantity of waste/equipment being disposed, disposal method (i.e. disposed by waste management company or waste recycling company etc.)	Once after completion of conversion	Safety officer of enterprises
Maintenance and calibrations (if relevant) records of equipment relevant to the conversion line including gas detection device, leak testing device, storage tank inspection, fire protection system etc.	Once a year	Manager of production line
Pre-start up inspection using Pre-startup check list (Annex D)	After commissioning of equipment	Safety officer of enterprises
Pre-start up audit	After commissioning of equipment and pre-start up inspection	DIW
Report on implementation of EMP using check list of safety measures indicated in Annex E.	Within one year after commissioning of equipment	Safety officer of enterprises
Post-start up audit	Within one year after commissioning of equipment and after submission of report on implementation of EMP	DIW

Proposed Safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums

Components / area	National requirements	Safety measures
CP drums stored outdoor in designated area	<p>National requirements for storage of CP in drums.</p> <p>DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550</p> <p>DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550</p> <p>The Notification of Ministry of Finance Subject Defined characteristic of Hydrocarbon Solvent B.E. 2552</p> <p>The Procedure for inspection the enterprises who are the suppliers of hydrocarbon solvents, and the inspection at the facility of the users of hydrocarbon solvents for industrial purposes B.E. 2554</p> <p>Requirements and guidance from CP supplier.</p>	Location of CP drums storage area approved by relevant authority.
		Drums in stored in area with fence around.
		Drums protected against direct exposure to sunlight.
		Electrical installation in the CP storage area as per Ex-area classification.
		Firefighting equipment.
		Safety marking and signs of storage area.
Indoor room for CP drums storage	<p>National requirement for storage of flammable gas inside buildings.</p> <p>Requirements and guidance from CP supplier.</p>	Rooms separated from foam production area and rest of the factory with fire resistance walls and doors.
		Access from outside directly to the CP storage room. (for delivery of CP drums and pickup of empty drums.)
		Ventilation system installed with capacity as specified by regulation/ supplier.
		Electrical installation as per Ex area classification.
		CP Gas detection system and CP gas detectors.
		Fire equipment as specified by authority.
		Safety marking and signs at storage area.
Delivery of drums	Requirements and specification from CP drum supplier.	Easy access for off-loading and loading CP drums and transportation to the CP storage room.
		Access to the room from the outside for delivery of drums.
		Storage area marked with signs and max storage capacity clearly shown.

Components / area	National requirements	Safety measures
Pre-mixing unit	As per the supplier specifications.	The premixing unit will normally include safety measures.

Proposed Safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums (Continue)

Components / area	National requirements	Safety measures
Foaming area and jigs	Recommendation by MLF and Foam equipment supplier.	HP foaming equipment designed for the use CP (ex-proof electrical installation and wiring).
		Grounding of foaming equipment and jigs.
		CP Gas system and gas detectors.
		Ventilation system installed with design capacity as specified by supplier.
		Electrical installations consistent with Ex area classification.
		Nitrogen system.
		Firefighting equipment.
Awareness and training	Involve local fire authority.	General awareness and training of workers.
Operational manual for workers involved in handling CP foaming	Supplier of foaming and safety equipment.	Training of workers involved in foaming.
		Use of spark free tools in areas with risk of CP.
Checking and maintenance of safety measures	Recommended practice by foam equipment supplier and suppliers of fire safety equipment and relevant safety authorities.	Develop and daily, monthly quarterly and annual program for checking and reporting.
Emergency plan	Prepared in cooperation with suppliers and local safety authorities.	Develop an emergency plan by internal team with advice from local fire safety authorities.

Check list of safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums

Components / area	National requirements	Safety measures	Complied / Implemented
CP drums stored outdoor in designated area	National requirements for storage of CP in drums. Requirements and guidance from CP supplier.	Location of CP drums storage area approved by relevant authority.	
		Drums in stored in area with fence around.	
		Drums protected against direct exposure to sunlight.	
		Electrical installation in the CP storage area as per Ex-area classification.	
		Firefighting equipment.	
		Safety marking and signs of storage area.	
Indoor room for CP drums storage	National requirement for storage of flammable gas inside buildings. Requirements and guidance from CP supplier.	Rooms separated from foam production area and rest of the factory with fire resistance walls and doors.	
		Access from outside directly to the CP storage room. (for delivery of CP drums and pickup of empty drums.)	
		Ventilation system installed with capacity as specified by regulation/ supplier.	
		Electrical installation as per Ex area classification.	
		CP Gas detection system and CP gas detectors.	
		Fire equipment as specified by authority.	
		Safety marking and signs at storage area.	

Check list of safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums (Continue)

Components / area	National requirements	Safety measures	Complied / Implemented
Delivery of drums	Requirements and specification from CP drum supplier.	Easy access for off-loading and loading CP drums and transportation to the CP storage room.	
		Access to the room from the outside for delivery of drums.	
		Storage area marked with signs and max storage capacity clearly shown.	
Pre-mixing unit	As per the supplier specifications.	The premixing unit will normally include safety measures.	
Foaming area and jigs	Recommendation by MLF and Foam equipment supplier.	HP foaming equipment designed for the use CP (ex-proof electrical installation and wiring).	
		Grounding of foaming equipment and jigs.	
		CP Gas system and gas detectors.	
		Ventilation system installed with design capacity as specified by supplier.	
		Electrical installations consistent with Ex area classification.	
		Nitrogen system.	
Awareness and training	Involve local fire authority.	General awareness and training of workers.	
Operational manual for workers involved in handling CP foaming	Supplier of foaming and safety equipment.	Training of workers involved in foaming.	
		Use of spark free tools in areas with risk of CP.	
Checking and maintenance of safety measures	Recommended practice by foam equipment supplier and suppliers of fire safety equipment and relevant safety authorities.	Develop and daily, monthly quarterly and annual program for checking and reporting.	
Emergency plan	Prepared in cooperation with suppliers and local safety authorities.	Develop an emergency plan by internal team with advice from local fire safety authorities.	

Environment Monitoring Plan for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums

Indicators	Schedule	Responsible party/person
Accident statistics and reporting	Once a year	Safety officer of enterprises
Fire drill/emergency drill records	Once a year	Safety officer of enterprises
Waste disposal record for conversion process indicating type and quantity of waste/equipment being disposed, disposal method (i.e. disposed by waste management company or waste recycling company etc.)	Once after completion of conversion	Safety officer of enterprises
Maintenance and calibrations (if relevant) records of equipment relevant to the conversion line including gas detection device, leak testing device, fire protection system etc.	Once a year	Manager of assembly line
<ul style="list-style-type: none"> • Cyclo-pentane drum safety inspection records; • Cyclo-pentane drum storage area inspection records. 	2 times / year	Safety officer of enterprises
Pre-start up inspection using Pre-startup check list (Annex D)	After commissioning of equipment	Safety officer of enterprises
Pre-start up audit	After commissioning of equipment and pre-start up inspection	DIW
Report on implementation of EMP using check list of safety measures indicated in Annex E.	Within one year after commissioning of equipment	Safety officer of enterprises
Post-start up audit	Within one year after commissioning of equipment and after submission of report on implementation of EMP	DIW

ANNEX F World Bank Environmental, Health and Safety (EHS) Guidelines

The World Bank Environmental, Health, and Safety (EHS) Guidelines are available at:

<http://www1.ifc.org/wps/wcm/connect/554e8d80488658e4b76af76a6515bb18/Final%2B-%2BGeneral%2BEHS%2BGuidelines.pdf?MOD=AJPERES>

ANNEX G Diagram of Foaming Set

Diagram of Existing HCFC-141b Foaming Set and
New HFC245fa Foaming Set in Cooled Storage Room

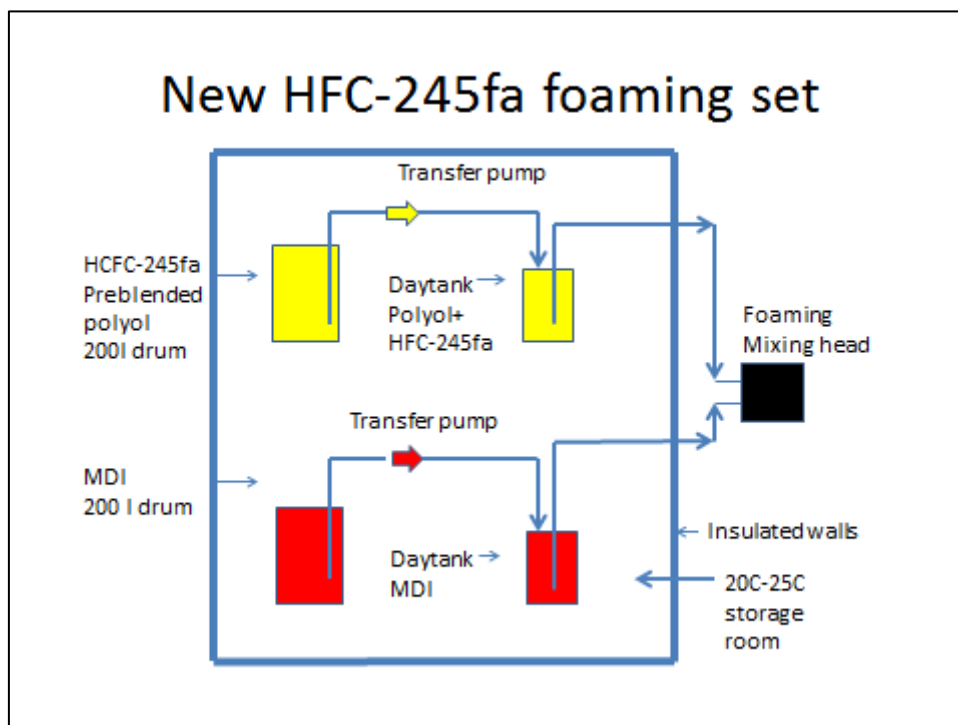
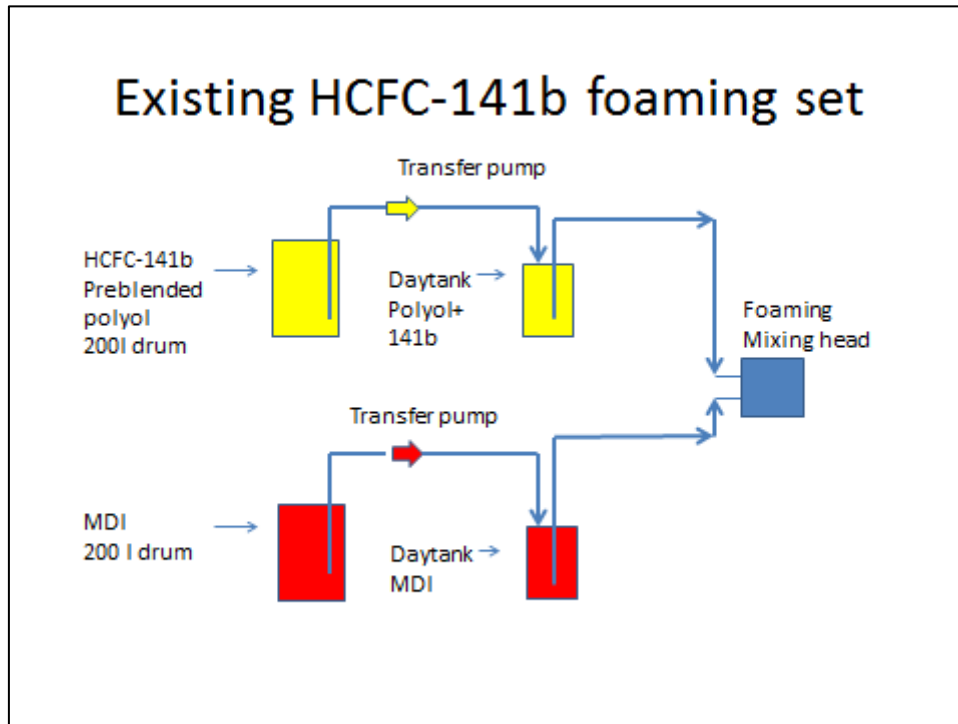
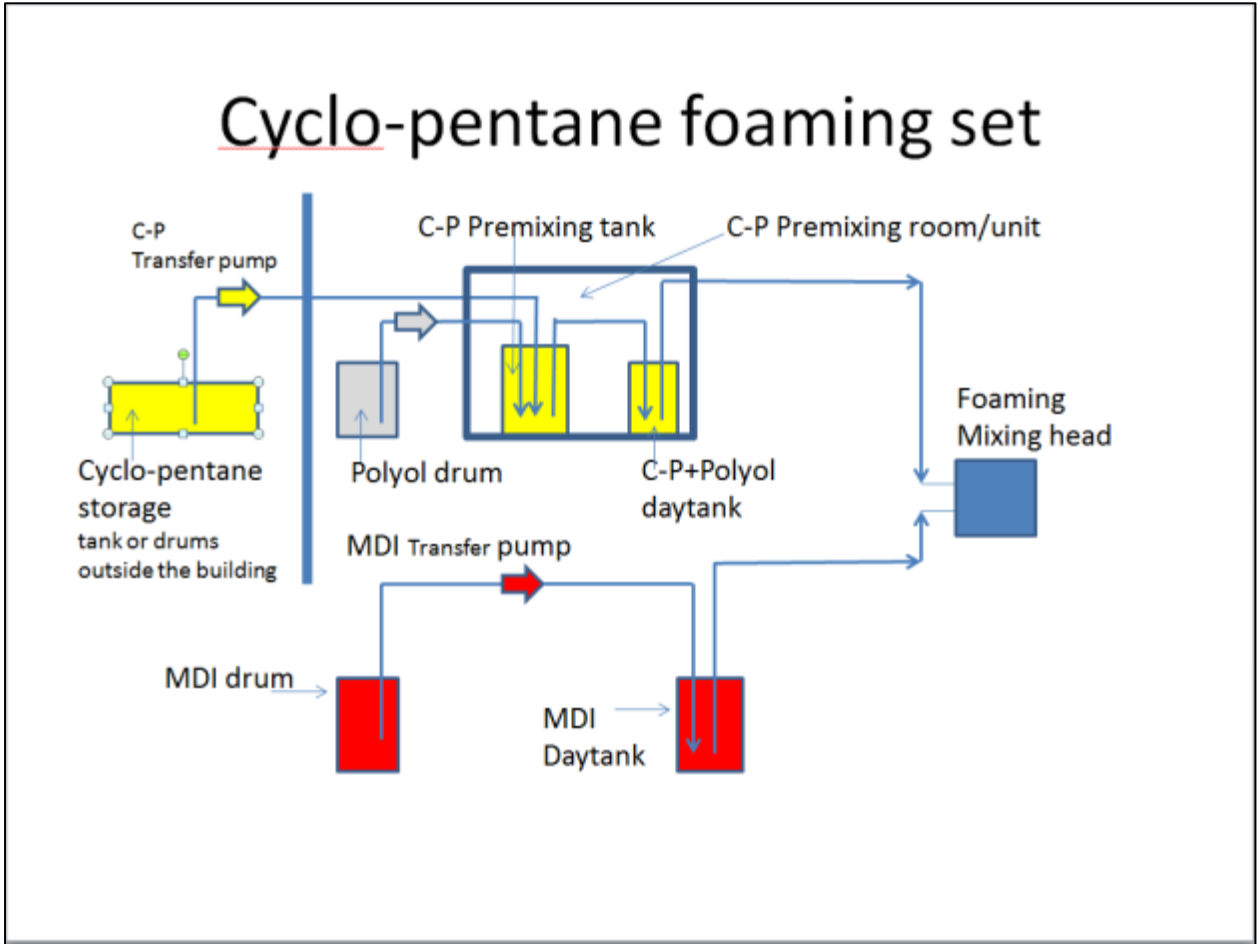


Diagram of New Cyclo-pentane Foaming Set with Storage and Premixing Room



Reference: Presentation document made by Fire protection expert from World Bank, Thai PU Foaming Setup, March 20, 2013.

ANNEX H Material Safety Data Sheet

Note: The following information is excerpted from original copies of the MSDS provided by the manufacturer of each chemical. Layout of the MSDS may differ. (Printed out copies of MSDS are provided as the attachment to this EMF.)

Detail description of the terminology contained on Material Safety Data Sheet can be found on a Chemical Data Bank, website of Pollution Control Department, Ministry of Natural Resources and Environment.

<http://msds.pcd.go.th/definition.html>

Safety data sheet Cyclopentane.

Creation date : 25.03.2011 Version : 1.21 GB/ E SDS No. : 257
Revision date : 25.05.2011 page 1 / 6

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name:	Cyclo-pentane
EC No (from EINECS):	206-016-6
CAS No:	287-92-3
Index-Nr.	601-030-00-2
Chemical formula	C ₅ H ₁₀
REACH Registration number:	01-2119463053-47

1.2. Relevant identified uses of the substance or mixture and uses advised against Relevant identified uses

Industrial and professional. Perform risk assessment prior to use.

Uses advised against

Consumer use.

1.3. Details of the supplier of the safety data sheet Company identification:

BOC, Priestley Road, Worsley, Manchester M28 2UT

E-Mail Address ReachSDS@boc.com

1.4. Emergency telephone number

Emergency phone numbers (24h): 0800 111 333

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture:

Classification acc. to Regulation (EC) No:	1272/2008/EC (CLP/GHS)
Flammable liquid:	Flam. Liq. 2 – Highly flammable liquid and vapour.
Aquatic Chronic	3 -Harmful to aquatic life with long lasting effects.

Classification acc. to Directive 67/548/EEC & 1999/45/EC:

F; R11 | R52-53

Highly flammable.

Harmful to aquatic organisms.

May cause long term adverse effects in the aquatic environment.

Risk advice to man and the environment

Contact with liquid may cause cold burns/frost bite

2.2. Label elements - Labeling Pictograms:



Signal word: Danger

Hazard Statements

H225 Highly flammable liquid and vapour
H412 Harmful to aquatic life with long lasting effects.

Precautionary Statements

Precautionary Statement Prevention

P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P240 Ground / bond container and receiving equipment.
P243 Take precautionary measures against static discharge.
P273 Avoid release to the environment.

Precautionary Statement Response

P233 Keep container tightly closed.
P241 Use explosion-proof electrical/ventilating/lighting/equipment.
P242 Use only non-sparking tools.
P280 Wear protective gloves/protective clothing/eye protection/face protection.
P303/361/353 IF ON SKIN (or hair):Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P370/378 In case of fire: Use only foam or powder fire extinguishers for extinction.

Precautionary Statement Storage

P403/235 Store in a well-ventilated place. Keep cool.

Precautionary Statement Disposal

P501 Dispose of contents and container in accordance with local regulations.

2.3. Other hazards:

Contact with liquid may cause cold burns/frost bite.
Repeated exposure may cause skin dryness or cracking.

SECTION 3: Composition/information on ingredients

Substance / Mixture: Substance.

3.1. Substances:

CAS No: 287-92-3
Index-Nr.: 601-030-00-2
EC No (from EINECS): 206-016-6
REACH Registration number: 01-2119463053-47

Contains no other components or impurities which will influence the classification of the product.

3.2. Mixtures:

Not applicable.

SECTION 4: First aid measures

4.1. Description of first aid measures:

First Aid General Information:

Remove victim to uncontaminated area wearing self-contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

First Aid Inhalation:

Remove victim to uncontaminated area wearing self-contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.

First Aid Skin / Eye:

In case of frostbite spray with water for at least 15 minutes. Apply a sterile dressing. Remove contaminated clothing. Drench affected area with water for at least 15 minutes. Obtain medical assistance. Immediately flush eyes thoroughly with water for at least 15 minutes.

First Aid Ingestion:

Do not give victim anything to drink if they are unconscious. Do NOT induce vomiting. Get immediate medical advice/attention.

4.2. Most important symptoms and effects, both acute and delayed:

In high concentrations may cause asphyxiation. Symptoms may include loss of mobility/consciousness. Victim may not be aware of asphyxiation. In low concentrations may cause narcotic effects. Symptoms may include dizziness, headache, nausea and loss of co-ordination.

4.3. Indication of any immediate medical attention and special treatment needed

Get immediate medical advice/attention.

SECTION 5: Fire fighting measures**5.1. Extinguishing media:**

Suitable extinguishing media: Use only carbon dioxide, water, foam or powder fire extinguishers for extinction.

Unsuitable extinguishing media: Do not use a solid water stream.

5.2. Special hazards arising from the substance or mixture:

Specific hazards: Exposure to fire may cause containers to rupture/explode.

Hazardous combustion products: If involved in a fire the following toxic and/or corrosive fumes may be produced by thermal decomposition: Carbon dioxide, Carbon monoxide.

5.3. Advice for fire-fighters Specific methods:

If possible, stop flow of product. Move container away or cool with water from a protected position. Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire. Prevent water used in emergency cases from entering sewers and drainage systems.

Special protective equipment for fire-fighters: Use self-contained breathing apparatus and chemically protective clothing. Clothing for fire-fighters (including helmets, protective boots and gloves) conforming to EN 469 will provide a basic level of protection from chemical incidents. Guideline: EN 469:2005: Protective clothing for fire-fighters. Performance requirements for protective clothing for firefighting.

SECTION 6: Accidental release measures**6.1. Personal precautions, protective equipment and emergency procedures:**

Consider the risk of potentially explosive atmospheres. Evacuate area. Ensure adequate air ventilation. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Eliminate ignition sources. Prevent from entering sewers, basements and work pits, or any place where its accumulation can be dangerous.

6.2. Environmental precautions: Try to stop release.

6.3. Methods and material for containment and cleaning up: Ventilate area. Keep away from ignition sources (including static discharges). Evacuate area. Prevent evaporation by covering with

foam. Absorb excess liquid spillage on inorganic adsorbent material such as fine sand, brick dust etc. Place spent adsorbent in sealed packages and contact specialist waste disposal contractor.

6.4. Reference to other sections: See also sections 8 and 13.

SECTION 7: Handling and storage

7.1. Precautions for safe handling:

Only experienced and properly instructed persons should handle the product. The substance must be handled in accordance with good industrial hygiene and safety procedures. Avoid contact with skin. Use only properly specified equipment which is suitable for this product, its supply pressure and temperature. Contact your supplier if in doubt. Take precautionary measures against static discharges. Ensure equipment is adequately earthed. Purge air from system before introducing product. Do not smoke while handling product. Assess the risk of potentially explosive atmosphere and the need for explosion-proof equipment. Consider the use of only non-sparking tools. Ensure the complete system has been (or is regularly) checked for leaks before use. Refer to supplier's handling instructions. Suck back of water into the container must be prevented. Do not allow back-feed into the container. Protect cylinders from physical damage; do not drag, roll, slide or drop. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. Keep container valve outlets clean and free from contaminants particularly oil and water. Replace valve outlet caps or plugs and container caps where supplied as soon as container is disconnected from equipment. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to transfer product from one cylinder/container to another. Never use direct flame or electrical heating devices to raise the pressure of a container. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents.

7.2. Conditions for safe storage, including any incompatibilities

Observe all regulations and local requirements regarding storage of containers. Segregate from oxidant gases and other oxidants in store. Keep container below 49°C in a well-ventilated place. Containers should be stored in the vertical position and properly secured to prevent falling over. Stored containers should be periodically checked for general conditions and leakage. Container valve guards or caps should be in place. Store containers in location free from fire risk and away from sources of heat and ignition. Keep away from combustible materials. All electrical equipment in the storage areas should be compatible with the risk of potentially explosive atmosphere. Containers should not be stored in conditions likely to encourage corrosion.

7.3. Specific end use(s)

None.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Exposure limit value

Value type value Note: TWA 600 ppm (AIHA)

DNEL not available

PNEC not available

8.2. Exposure controls

Appropriate engineering controls

A risk assessment should be conducted and documented in each work area to assess the risks related to the use of the product and to select the PPE that matches the relevant risk.

The following recommendations should be considered. Gas detectors should be used when quantities of flammable gases/vapours may be released. The substance must be handled in accordance with good industrial hygiene and safety procedures. Consider work permit system e.g. for maintenance activities. Systems under pressure should be regularly checked for leakages. Provide adequate general or local ventilation. Keep concentrations well below occupational exposure limits. Keep concentrations well below lower explosion limits.

Personal protective equipment

Eye and face protection

Protect eyes, face and skin from liquid splashes. Wear a face -shield when transfilling and breaking transfer connections. Safety eyewear, goggles or face-shield to EN166 should be used to avoid exposure to liquid splashes.

Full-face mask recommended Guideline:

EN: EN136 Respiratory protective devices. Full face masks. Requirements, testing, marking.

Skin protection

Hand protection:

Wear cold insulating gloves.

Guideline:

EN 511 Protective gloves against cold. Wear working gloves and safety shoes when handling cylinders.

Body protection

Protect eyes, face and skin from contact with product. Keep suitable chemically resistant protective clothing readily available for emergency use. Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Guideline:

EN 943: Protective clothing against liquid and gaseous chemicals, aerosols and solid particles.

Other protection

Wear flame resistant/retardant clothing. Take precautionary measures against static discharges. Wear working gloves and safety shoes while handling cylinders. ISO 20345 Safety footwear.

Respiratory protection

Keep self contained breathing apparatus readily available for emergency use. Use SCBA in the event of high concentrations. The selection of the Respiratory Protective Device (RPD) must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected RPD. When allowed by a risk assessment Respiratory Protective Equipment (RPE) may be used.

Guideline:
EN 136: Respiratory protective devices. Full face masks. Requirements, testing, marking. Material:
Filter AX

Guideline:
EN 14387: Respiratory protective devices. Gas filter(s) and combined filter(s). Requirements, testing,
marking

Environmental Exposure Controls

Refer to local regulations for restriction of emissions to the atmosphere. See section 13 for specific methods for waste product treatment. Specific risk management measures are not required beyond good industrial hygiene and safety procedures. Provide adequate general or local ventilation.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical Properties:

General information:

Appearance/Colour:	Colourless liquid.
Odour:	Faint. Poor warning properties at low concentrations.
Odour threshold:	Odour threshold is subjective and inadequate to warn for over exposure.
Melting point:	-94 °C
Boiling point:	49 °C
Flash point:	< -39 °C
Flammability range:	1,1 %(V) – 8,7 %(V)
Vapour Pressure 20 °C:	0,35 bar
Relative density, gas:	2,4
Solubility in water:	156 mg/l at 25°C
Partition coefficient: n-octanol/water:	No data available.
Auto-ignition temperature:	361 °C
Molecular weight:	70.14 g/mol
Relative density, liquid:	0.7

9.2. Other information:

Gas/vapour heavier than air. May accumulate in confined spaces, particularly at or below ground level.

SECTION 10: Stability and reactivity

10.1. Reactivity: Unreactive under normal conditions.

10.2. Chemical stability: Stable under normal conditions.

10.3. Possibility of hazardous reactions:

Can form potential explosive atmosphere in air., May react violently with oxidants.

10.4. Conditions to avoid: Keep away from heat/sparks/open flames/hot surfaces. – No smoking.

10.5. Incompatible materials: Air, Oxidizer.

10.6. Hazardous decomposition products:

Under normal conditions of storage and use, hazardous decomposition products should not be produced. If involved in a fire the following toxic and/or corrosive fumes may be produced by thermal decomposition: Carbon dioxide, Carbon monoxide.

SECTION 11: Toxicological information

11.1. Information on toxicological effects:

Acute oral toxicity

Value: LD50
Species: Rat
Value in non-standard unit: 11.400 mg/kg

Acute inhalation toxicity

Value: LC50
Species: Mouse
Exposure time: 2 h
Value in non-standard unit: 106 mg/l
Value: LC50
Species: Rat
Value in non-standard unit: 106.000 m³

Acute dermal toxicity

Not available

Acute toxicity other routes: May cause pneumonia if swallowed and enters airways.

Skin irritation

Irritating to skin. Repeated exposure may cause skin dryness or cracking. May cause dermatitis by skin contact.

Eye irritation

Irritating to eyes. May cause mild, short-term discomfort to eyes.

Sensitization

No data available.

Repeated dose toxicity

Suppression of weight gain.

Assessment mutagenicity

No data available

Assessment carcinogenicity

No evidence of carcinogenic effects.

Assessment toxicity to reproduction

No data available.

Assessment teratogenicity

No data available.

Experiences with human exposure

Symptoms may include dizziness, headache, nausea, unconsciousness, irritation of the mucous membranes and dry coughs.

SECTION 12: Ecological information

12.1. Toxicity: May cause long-term adverse effects in the aquatic environment.

Acute and prolonged toxicity fish

Species: Coho salmon (*Oncorhynchus kisutch*)

Exposure time: 24 h
Value type: LC50
Value in standard unit mg/l: >100 mg/l

Acute toxicity aquatic invertebrates

Species: Crustaceans
Exposure time: 24 h
Value type: EC50
Value in standard unit mg/l: 19.6 mg/l

Toxicity aquatic plants

Species: Algae
Exposure time: 3h
Value type: EC50
Value in standard unit mg/l: 116 mg/l

12.2. Persistence and degradability

Biodegradation: 0%
Time: 4 days

12.3. Bioaccumulative potential

Bioaccumulation: log Kow = 3

Because of the partition coefficient of the contaminant in the organic fraction of the soil (log Kow), accumulation in organisms is not to be expected.

12.4. Mobility in soil

Floats on water. Evaporates within a day from water or soil surfaces.

12.5. Results of PBT and vPvB assessment

No data available

12.6. Other adverse effects

None.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Do not discharge into areas where there is a risk of forming an explosive mixture with air. Waste product should be flared through a suitable burner with flash back arrestor. Toxic and corrosive gases formed during combustion should be scrubbed before discharge to atmosphere. Do not discharge into any place where its accumulation could be dangerous. Contact supplier if guidance is required.

SECTION 14: Transport information

ADR/RID

14.1. UN number: 1146
14.2. UN proper shipping name: CYCLOPENTANE
14.3. Transport hazard class(es)
Class: 3
Classification Code: F1
Labels: 3
Hazard number: 33
Emergency Action Code: 3YE
Tunnel code: (D/E)

14.4. Packing group (Packing Instruction): II

14.5. Environmental hazards: Environmentally Hazardous.

14.6. Special precautions for user: None.

IMDG

14.1. UN number: 1146
14.2. UN proper shipping name: CYCLOPENTANE
14.3. Transport hazard class(es)
Class: 3

Labels: 3
EmS: FE,SD

14.4. Packing group (Packing Instruction) II
14.5. Environmental hazards: Environmentally Hazardous
14.6. Special precautions for user: None.
14.7. Transport in bulk according to Annex II of

MARPOL73/78 and the IBC Code

Substance name: CYCLOPENTANE
Ship type required: 2
Pollution category: Y

IATA

14.1. UN number: 1146
14.2. UN proper shipping name: CYCLOPENTANE
14.3. Transport hazard class(es)
Class: 3
Labels: 3

14.4. Packing group (Packing Instruction) II
14.5. Environmental hazards: Environmentally Hazardous.
14.6. Special precautions for user: None.

Other transport information:

Avoid transport on vehicles where the load space is not separated from the driver's compartment.

Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. Before transporting product containers ensure that they are firmly secured.

Ensure that the cylinder valve is closed and not leaking. Ensure that the valve outlet cap nut or plug (where provided) is correctly fitted.

Ensure that the valve protection device (where provided) is correctly fitted.

Ensure adequate ventilation.

Ensure compliance with applicable regulations.

SECTION 15: Regulatory information

15.1. Safety, health and environmental regulations/legislation specific for the substance or Mixture: Seveso Directive 96/82/EC: Covered.

15.2. Chemical safety assessment: CSA has not been carried out

SECTION 16: Other information

Ensure all national/local regulations are observed. Ensure operators understand the flammability hazard. The hazard of asphyxiation is often overlooked and must be stressed during operator training.

Before using this product in any new process or experiment, a thorough material compatibility and safety study should be carried out.

Advice

Whilst proper care has been taken in the preparation of this document, no liability for injury or damage resulting from its use can be accepted. Details given in this document are believed to be correct at the time of going to press.

Further information:

Note:

When using this document care should be taken, as the decimal sign and its position complies with rules for the structure and drafting of international standards, and is a comma on the line. As an example 2,000 is two (to three decimal places) and not two thousand, whilst 1.000 is one thousand and not one (to three decimal places).

End of document

Material Safety Data Sheet

Polyol

Bayer Material Science LLC
Product Safety & Regulatory Affairs 100 Bayer Road
Pittsburgh, PA 15205-9741 USA

TRANSPORTATION EMERGENCY
CALL CHEMTREC: (800) 424-9300
INTERNATIONAL: (703) 527-3887

NON-TRANSPORTATION
Emergency Phone: Call Chemtrec
Information Phone: (800) 662-2927

1. Product and Company Identification:

Product Name: BAYTEC ENC 5502P

Material Number: 5210690

2. Hazards Identification:

Emergency Overview

Caution: Color: Amber Form: liquid Odor: slight. Use cold water spray to cool fire-exposed containers to minimize the risk of rupture. May cause eye irritation.

Potential Health Effects

Primary Routes of Entry: Skin Contact, Eye Contact

Medical Conditions Aggravated by

Exposure: Eye disorders, Respiratory disorders, Skin disorders

HUMAN EFFECTS AND SYMPTOMS OF OVEREXPOSURE

Skin

Acute Skin

For Component: Polyether Polyol

May cause slight irritation.

Eye

Acute Eye

For Component: Polyether Polyol

May cause irritation with symptoms of reddening, tearing and stinging.

Carcinogenicity: No Carcinogenic substances as defined by IARC, NTP and/or OSHA

3. Composition/Information on Ingredients

Hazardous components

Weight percent Components CAS-No.

>=95% Polyether Polyol 25214-63-5

4. First aid measures

Eye contact

In case of contact, flush eyes with plenty of lukewarm water. Get medical attention if irritation develops.

Skin contact

In case of skin contact, wash affected areas with soap and water. Immediately remove contaminated clothing and shoes. Get medical attention if irritation develops.

Inhalation

If inhaled, remove to fresh air. Get medical attention if irritation develops.

Ingestion

If ingested, do not induce vomiting unless directed to do so by medical personnel. Get medical attention.

5. Firefighting measures

Suitable extinguishing media: Carbon dioxide (CO₂), Dry chemical, Foam, water spray for large fires.

Special Fire Fighting Procedures

Firefighters should be equipped with self-contained breathing apparatus to protect against potentially toxic

and irritating fumes. Use cold water spray to cool fire-exposed containers to minimize the risk of rupture.

6. Accidental release measures

Spill and Leak Procedures

Cover spill with inert material (e. g., dry sand or earth) and collect for proper disposal. Use appropriate personal protective equipment during clean up. Evacuate and keep unnecessary people out of spill area.

7. Handling and storage

Storage temperature:

Minimum: 15 °C (59 °F)

Maximum: 49 °C (120.2 °F)

Storage period: 36 Months

Handling/Storage Precautions:

Handle in accordance with good industrial hygiene and safety practices. Wash thoroughly after handling.

Keep container closed when not in use. Material is hygroscopic and may absorb small amounts of atmospheric moisture. If contamination with Isocyanates is suspected, do not reseal containers. Avoid breathing dust, vapor, or mist. Avoid contact with eyes. Avoid contact with skin or clothing.

Further Info on Storage Conditions

Employee education and training in the safe use and handling of this product are required under the OSHA

Hazard Communication Standard 29 CFR 1910.1200. Keep away from food and drink.

8. Exposure controls/personal protection

Country specific exposure limits have not been established or are not applicable

Industrial Hygiene/Ventilation Measures

Use local and general exhaust ventilation to control levels of exposure.

Respiratory protection

None required under normal conditions of use.

Hand protection

Permeation resistant gloves.

Eye protection

Chemical safety goggles or safety glasses with side-shields.

Skin and body protection

Wear cloth work clothing including long pants and long-sleeved shirts.

Additional Protective Measures

Employees should wash their hands and face before eating, drinking, or using tobacco products. Educate and train employees in the safe use and handling of this product.

9. Physical and chemical properties

Form: liquid

Color: Amber

Odor: slight

Flash point: 196 °C (384.8 °F)

Density: 1.02 g/cm³ @ 20 °C (68 °F)

Specific Gravity: 1.02 @ 25 °C (77 °F)

Solubility in Water: completely soluble

Decomposition temperature: Not established

Viscosity, dynamic: ca. 18,000 mPa.s @ 25 °C (77 °F)

Bulk density: 1,020 kg/m³

10. Stability and reactivity

Hazardous Reactions

Hazardous polymerisation does not occur.

Stability

Stable

Materials to avoid

Oxidizing agents, Isocyanates

Conditions to avoid

Avoid heat, flames, sparks and other sources of ignition.

Hazardous decomposition products

By Fire: Carbon Dioxide; Carbon Monoxide; other aliphatic fragments which have not been determined

11. Toxicological information

Toxicity Data for Polyether Polyol

Acute oral toxicity

LD50: > 5,000 mg/kg (rat, male) (OECD Test Guideline 401)

Acute dermal toxicity

LD50: > 2,000 mg/kg (OECD Test Guideline 402)

Skin irritation

Rabbit, OECD Test Guideline 404, slight irritant

Eye irritation

Rabbit, moderate irritant

12. Ecological information

Ecological Data for Polyether Polyol

Biodegradation

Aerobic, < 50 %, Exposure time: 28 d

Acute and Prolonged Toxicity to Fish

LC0: > 1,000 mg/l (Zebra fish (Brachydanio rerio), 48 h)

Toxicity to Microorganisms

EC0: > 1,000 mg/l, (Activated sludge microorganisms, 3 h)

13. Disposal considerations

Waste Disposal Method

Waste disposal should be in accordance with existing federal, state and local environmental control laws.

Empty Container Precautions

Recondition or dispose of empty container in accordance with governmental regulations.

14. Transport information

Land transport (DOT)

Non-Regulated

Sea transport (IMDG)

Non-Regulated

Air transport (ICAO/IATA)

Non-Regulated

15. Regulatory information

United States Federal Regulations

OSHA Hazcom Standard Rating: Hazardous

US. Toxic Substances Control Act: Listed on the TSCA Inventory.

US. EPA CERCLA Hazardous Substances (40 CFR 302):

Components

None

SARA Section 311/312 Hazard Categories:

Acute Health Hazard

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III

Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A):

Components

None

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III

Section 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required:

Components

None

US. EPA Resource Conservation and Recovery Act (RCRA) Composite List of Hazardous Wastes and Appendix VIII Hazardous Constituents (40 CFR 261)

Under RCRA, it is the responsibility of the person who generates a solid waste, as defined in 40 CFR

261.2, to determine if that waste is a hazardous waste.

State Right-To-Know Information

The following chemicals are specifically listed by individual states; other product specific health and safety data in other sections of the MSDS may also be applicable for state requirements. For details on your regulatory requirements you should contact the appropriate agency in your state.

Massachusetts, New Jersey or Pennsylvania Right to Know Substance Lists:

Weight percent Components CAS-No.

>=95% Polyether Polyol 25214-63-5

California Prop. 65:

To the best of our knowledge, this product does not contain any of the listed chemicals, which the state of

California has found to cause cancer, birth defects or other reproductive harm.

16. Other information

NFPA 704M Rating

Health =1

Flammability =1

Reactivity =0

Other

0=Insignificant 1=Slight 2=Moderate 3=High 4=Extreme

HMIS Rating

Health =1

Flammability =1

Physical Hazard =0

0=Minimal 1=Slight 2=Moderate 3=Serious 4=Severe

* = Chronic Health Hazard

The method of hazard communication for Bayer Material Science LLC is comprised of Product Labels and

Material Safety Data Sheets. HMIS and NFPA ratings are provided by Bayer Material Science LLC as a customer service.

Contact person: Product Safety Department

Telephone: (412) 777-2835

MSDS Number: 112000024145

Version Date: 10/11/2012

Report version: 1.10

**MATERIAL SAFETY DATA SHEET
ISOCYANATE – MDI**

Date of Issue: November 1999

Non Hazardous according to criteria of Worksafe Australia

COMPANY DETAILS:

Company: Barnes Products Pty Limited
Address: 6 Homedale Road, Bankstown NSW 2200
Telephone Number: (02) 9793 7555
Emergency Telephone Number: 0414 684 875
Facsimile Number: (02) 9793 7091

IDENTIFICATION:

Product Name: ISO - MDI
Other Names: Polymeric MDI, Polyphenylmethane Polyisocyanate, Crude MDI
Manufacturers Product Code: AUS MDI
UN Number: Not applicable
Hazchem Code: Not applicable
Poisons Schedule Number: Not applicable
Packaging Group: Not applicable
Use: Raw material for production of Polyurethane.
Recommended Method of Application: Hand mixing/pouring, machine injection/spraying

PHYSICAL AND CHEMICAL PROPERTIES:

Appearance: Brown Liquid
Boiling Point (°C): 180->200 @ 5 mmHg
Melting Point (°C): Not applicable
Vapour Pressure: <0.00001 mmHg @ 25°C
Specific Gravity: 1.23 g/ml (25°C)
Flashpoint (°C): > 200 (ASTM D-93, PMCC)
Flammability Limits (%): Not applicable
Solubility in Water (g/l): Insoluble, reacts slowly

INGREDIENTS:

Chemical Entity CAS Number Proportion
Diphenylmethane-4,4'-diisocyanate 101-68-8 30-60% w/w
Polymethylene Polyphenyl Isocyanate 9016-87-9 30-60% w/w

HEALTH HAZARD INFORMATION

Health Effects

Acute – Ingestion:

Ingestion of this product causes vomiting, nausea and abdominal pain. Single dose oral toxicity is considered to be extremely low. No hazards anticipated from swallowing small amounts incidental to normal handling operations. The oral LD50 for rats is >10,000 mg/kg.

Acute – Eye:

May cause slight eye irritation. Corneal injury is unlikely.

Acute – Skin:

Prolonged or repeated exposure may cause skin irritation. May stain the skin. Skin contact may result in allergic skin reactions or respiratory sensitisation but is not expected to result in absorption of amounts sufficient to cause other adverse effects. The LD50 for skin absorption in rabbits is >9400 mg/kg.

Acute – Inhaled:

At room temperature, vapours are minimal due to low vapour pressure. However, certain operations may generate vapour or aerosol concentrations sufficient to cause irritation or other adverse effects. Such operations include those in which the material is heated, sprayed or otherwise mechanically dispersed such as drumming, venting or pumping. Excessive exposure may cause irritation of the eyes, upper respiratory tract and lungs. May cause respiratory sensitisation in susceptible individuals. MDI concentrations below the exposure standards may cause allergic respiratory reactions in individuals already sensitised. Symptoms may include coughing, difficult breathing and feeling of tightness in chest. Effects may be delayed. Impaired lung function (decreased ventilator capacity) has been associated with overexposure to Isocyanates.

Chronic Effects

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS: Tissue injury in the upper respiratory tract and lungs has been observed in laboratory animals after repeated excessive exposures to MDI/Polymeric MDI aerosols.

CANCER INFORMATION: Lung tumors have been observed in laboratory animals exposed to aerosol droplets of MDI/Polymeric MDI (6mg/m³) for their lifetime. Tumors occurred concurrently with respiratory irritation and lung injury. Current exposure standards are expected to protect against these effects.

TERATOLOGY (BIRTH DEFECTS): In laboratory animals, Polymeric MDI did not produce birth defects, other fetal effects occurred only at high doses, which were toxic to the mother.

Other Health hazard Information: Industrial experience has shown no evidence of carcinogenicity of MDI in humans. An animal study indicates that MDI may induce hypersensitivity following dermal exposure.

FIRST AID MEASURES

Ingestion:

Never give fluids or induce vomiting if patient is unconscious or is having convulsions. If poisoning occurs, contact a doctor or Poisons Information Centre. If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

Eye:

Flush eyes with running water for 15 minutes with eyelids held open. Materials containing MDI may react with the moisture of the eye forming a thick material, which may be difficult to wash from the eyes.

Skin:

In case of skin contact, immediately flush skin with plenty of water (warm, soapy water, if available) for at least 15 minutes while removing contaminated clothing and shoes.

Inhalation:

Remove to fresh air. If not breathing, apply mouth to mouth resuscitation. If breathing is difficult, qualified personnel should administer oxygen. Call a doctor and/or transport to an emergency hospital.

Other Information:

An eye wash fountain, safety shower and a general washing facility should be available in immediate work area.

GENERAL ADVICE TO DOCTOR

The manifestations of respiratory symptoms, including pulmonary edema, resulting from acute exposure may be delayed. No specific antidote is known. Supportive care. Treatment based on judgment by the doctor in response to reactions of the patient.

PRECAUTIONS FOR USE

Exposure Limits

Other Exposure info:

Workplace Exposure Standard (ES) # for:

Isocyanates (as-NCO): 0.02mg/m³, TWA: 0.07mg/m³, STEL: Sen.

Exposure Standard for Atmospheric Contaminants in the Occupational Environment, published by Worksafe Australia.

TWA – time weighted average exposure

STEL – short term exposure limit

SEN – Sensitiser

Engineering Controls: Provide general and/or local exhaust ventilation to control airborne levels below the exposure standards.

PERSONAL PROTECTION

Contact of the reacting materials with the skin or eyes can cause severe burns and may be difficult to remove from the affected areas. Immediately wash affected areas with plenty of water (warm soapy water, if available) and seek medical attention. In addition such contact increases the risk of exposure to Isocyanate vapours. Use only approved protective clothing and equipment when handling this material (refer to Australian Standards below).

Respiratory Protection: Atmospheric levels should be maintained below the Exposure Standard. When respiratory protection is required for certain operations, use an approved positive pressure supplied-air respirator. For emergency and other conditions where the exposure standard may be greatly exceeded, use an approved positive pressure self-contained breathing apparatus or positive-pressure airline with auxiliary self-contained air supply.

Skin Protection:

Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron or full body suit will depend on operation. Remove contaminated clothing immediately, wash skin area with soap and water (warm soapy water if available) and launder clothing before reuse.

Glove Type:

AS2161: Industrial Safety Gloves and Mittens (excluding electrical and medical gloves)

Eye/Face Protection:

Use approved safety glasses. If vapour exposure causes eye discomfort, use a full face respirator. Selection and use of personal protective equipment should be in accordance with the recommendations in one or more of the relevant Australia Standards, including: AS1336: recommended practices for eye protection in the industrial environment. AS/NZS 1337: Eye protectors for industrial application. AS/NZS 1715: Selection, use and maintenance of respiratory protective devices.

Clothing:

AS/NZS 2210: Occupational protective footwear. AS2919: Industrial Clothing.

FLAMMABILITY

Fire Hazards: Will support combustion. Toxic fumes are released in fire situations. Sources of Ignition: Incompatible with oxidizing agents, acids, alkalies, alcohols, water; keep away from all heat and ignition sources.

SAFE HANDLING INFORMATION

STORAGE AND TRANSPORT

Storage Precautions: Store indoors at 15-25°C in original, unopened containers. Protect from atmospheric moisture. Replace outage with inert dry gas Nitrogen. Avoid product temperatures above 40°C and below 15°C. At temperatures below 15°C crystallization may occur. Crystallized product can be melted by heating overnight to 60-70°C. Store away from oxidizing agents, alkalies, acids, amines, direct sunlight or any source of ignition or heat.

SPILLS AND DISPOSAL

Protect People: Evacuate and ventilate spill area. Contain spill, eg, by diking, to prevent entry into sewers, drains or water systems. Wear full protective equipment including respiratory equipment during clean up.

Major Spill:

If transportation spill Dial 000 for Police or Fire Brigade. If temporary control of Isocyanate vapour is required a blanket of protein foam (available at most Fire Brigades) may be placed over the spill. Large quantities may be pumped into closed but not sealed containers for disposal.

Minor Spill:

Absorb the Isocyanate with sawdust or other absorbent and shovel into open top containers do not make pressure tight. Transport to well ventilated area (outside) and treats with neutralizing solution consisting of a mixture of water and 3-8% concentrated ammonium hydroxide or 5-10% sodium carbonate. Add about 10 parts of neutralizer per part of Isocyanate with mixing. Allow to stand for 48 hours letting evolved carbon dioxide escape.

Clean Up:

Decontaminate floor using decontaminate solution mix of 90% water, 5% ammonia and 5% detergent. Allow to stand over affected area for at least 10 minutes. Cover mops and brooms with plastic and dispose properly (often by incineration). Personnel to wear self contained breathing apparatus and full protective clothing.

Disposal:

Any disposal of product, drain and rinse liquid, or containers, must be in accordance with the State, territory and/or Local Government regulations. Liquids are usually incinerated in an approved facility. Solids are usually also incinerated or land filled in approved facilities. Empty plastic or steel drums should first be decontaminated by filling with water or decontaminated solution. Let drums stand unsealed for at least 48 hours. Before disposal drums should be drained, triple rinsed with water, and holed or crushed to prevent reuse. The other option is to offer the undamaged, empty and decontaminated containers to a qualified reconditioned or recycler. A suggested method for disposal for drain and rinse liquids is by treatment in an approved wastewater treatment system. Suggested methods for disposal of plastic containers are either disposal in an approved landfill after shredding or incineration in an approved industrial incinerator or other appropriate incinerator facility. Steel drums are commonly crushed for disposal and sent to an approved landfill. Chemical additions, processing, storage, or otherwise altering the material may make the waste management information presented in this MSDS incomplete, inaccurate or otherwise inappropriate. Waste characterization and disposal compliance are the responsibility solely of the party generating the waste or deciding to discard or dispose of the material. None of the waste management options should be considered 'arranging for disposal'.

FIRE/EXPLOSION HAZARD

Hazardous Combustion Products: Isocyanate vapour and mist, carbon dioxide, carbon monoxide, nitrogen oxides and traces of Hydrogencyanide.

Fire Fighting Equipment:

People who are fighting Isocyanate fires must be protected against Isocyanate vapours and hazardous combustion products by wearing positive pressure self contained breathing apparatus and full protective clothing.

Extinguishing Media:

Carbon dioxide, dry chemical foam. For large fires, alcohol resistant foams are preferred if available. General purpose synthetic foams or protein foams may function, but much less effectively. Water may be used as a blanket for fire extinguishment. If water is used, it should be used in very large quantities. The reaction between water and Isocyanate may be vigorous. If possible, contain fire runoff water.

Fire Fighting Instructions:

In case of fire use large quantities of water, foam, carbon dioxide or dry chemical. Downwind personnel must be evacuated. Do not reseal contaminated containers. A chemical reaction generating carbon may occur resulting in rupture of the container. Dense smoke emitted when burned without sufficient oxygen. When using water spray, boil over may occur when the product temperature reaches boiling point of water and the reaction forming carbon dioxide will accelerate (tank type scenarios, not spills). Hot MDI reacts vigorously with small amounts of water.

HAZARDOUS REACTION

Chemical Stability

Conditions to Avoid:

Prolonged heating over 45°C. Stable when stored under normal conditions. Thermal decomposition begins at temperatures above 177°C.

Incompatibility with other Materials:

Water, acid, bases, alcohols, and metal compounds. Avoid water as it reacts to form heat and carbon dioxide. Enough heat and pressure can be produced to rupture a closed container. The reaction with water is slow at temperatures less than 49°C, but accelerated at higher temperature and in the presence of the above mentioned materials. Some reactions are violent.

Hazardous Decomposition Products:

Excessive heating can produce Isocyanate vapour, mist and other hazardous compounds.

Hazardous Polymerization:

May occur with incompatible reactants, especially strong bases, water, or temperatures over 160°C.

OTHER INFORMATION

Toxicology

Swallowed: The oral LD50 for rats is greater than 10,000 mg/kg.

Skin: The LD50 for skin absorption in rabbits is greater than 9,400 mg/kg.

Mutagenicity: Mutagenicity data on the MDI are inconclusive. MDI was weakly positive in some in vitro (test tube) studies; other in vitro studies were negative. A mutagenicity study in animals was negative.

ECOLOGICAL INFORMATION

Avoid contaminating waterways, drains, sewers or ground.

Movement & Partitioning:

Movement in the environment is expected to be limited by the formation of insoluble polymers.

Degradation & Transportation:

Biodegradation is not applicable (for the Isocyanate itself). Material is expected to be biodegrade only very slowly. Fails to pass OECD modified MITI test; hydrolysis products degrade slowly. Degradation is expected in the atmospheric environment.

Ecotoxicity:

Material is practically non-toxic to aquatic organisms on an acute basis (LD50 greater than 100 mg/l in most sensitive species).

PACKAGING & LABELLING INFORMATION

Quantities in excess of 25kgs are labelled in accordance with the Code of Practice for Labeling Workplace Substances. Repacking of this product into quantities less than 25kgs to be in accordance with the SUSDP requirements for this substance.

HAZARDOUS SUBSTANCES CLASSIFICATION: Harmful. Irritant. Sensitiser.

RISK PHRASES:

R20. Harmful by inhalation.

R36/37/38. Irritating to eyes, respiratory system and skin.

R42. May cause sensitisation by inhalation.

SAFETY PHRASE:

S26. In case of contact with the eyes, rinse immediately with plenty of water and contact a doctor or Poisons Information Centre.

S28. After contact with skin, wash immediately with plenty of water warm, soapy if available).

S38. In case of insufficient ventilation, wear suitable respiratory equipment.

S45. In case of accident or if you feel unwell, contact a doctor or Poisons information Centre immediately (show the label where possible).

Manufacturers Advice:

The principal components and additives of this product are included in the Australian Inventory of Chemical Substances (AICS).

References: Worksafe Australia Guide "ISOCYANATES". Australian Government Publishing Service Canberra

July 1990. Code WAP90/017 GS012-1990.

CONTACT POINT

Managing Director (02) 9793 7555

After Hours 0414 684 875

Material Safety Data Sheet HFC-245fa

The MSDS format adheres to the standards and regulatory requirements of the United States and may not meet regulatory requirements in other countries.

DuPont

6142FR Revised 16-JUN-2001

CHEMICAL PRODUCT/COMPANY IDENTIFICATION

Material Identification

CAS Number: 460-73-1

Formula: CF₃CH₂CHF₂

Molecular Weight: 134.05

CAS Name: 1, 1, 1, 3, 3-Pentafluoropropane

Trade names and Synonyms

HFC-245FA

Company Identification

MANUFACTURER/DISTRIBUTOR

DuPont

Fluoro products

1007 Market Street

Wilmington, DE 19898

PHONE NUMBERS

Product Information: 1-800-441-7515 (outside the U.S.

302-774-1000)

Transport Emergency: CHEMTREC 1-800-424-9300(outside U.S.

703-527-3887)

Medical Emergency: 1-800-441-3637 (outside the U.S.

302-774-1000)

COMPOSITION/INFORMATION ON INGREDIENTS

Components

Material CAS Number %

1, 1, 1, 3, 3-PENTAFLUOROPROPANE 460-73-1 99-100

HAZARDS IDENTIFICATION

Potential Health Effects

Frostbite may occur if the liquid or escaping vapors from HFC-245fa contact the eyes.

HFC-245fa may cause frostbite, if liquid or escaping vapor contacts the skin.

HFC-245fa vapors are heavier than air and pose a threat of suffocation if trapped in enclosed or low places.

May cause temporary alteration of the heart's electrical activity with irregular pulse, palpitations, or inadequate circulation, or the effects of exclusion of oxygen with grossly excessive exposures.

Carcinogenicity Information

None of the components present in this material at concentrations equal to or greater than 0.1% are listed by IARC, NTP, OSHA or ACGIH as a carcinogen.

FIRST AID MEASURES

First Aid

INHALATION

If inhaled, immediately remove to fresh air. Keep person calm. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.

SKIN CONTACT

Flush area with lukewarm water. Do not use hot water. If frostbite has occurred, call a physician.

EYE CONTACT

In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Call a physician.

INGESTION

If swallowed, no specific intervention is indicated as the compound is not likely to be hazardous by ingestion. However, consult a physician if necessary.

Notes to Physicians

THIS MATERIAL MAY MAKE THE HEART MORE SUSCEPTIBLE TO ARRHYTHMIAS.

Catecholamine such as adrenaline, and other compounds having similar effects, should be reserved for emergencies and then used only with special caution.

FIRE FIGHTING MEASURES

Flammable Properties

Flash Point: None, as tested by ASTM D3828-87; ASTM D1310-86.

Flammable limits in Air, % by volume: none, as tested by the procedure UL-2182 at 100 deg C test temperature, 50% ambient air humidity and most recent criteria for ignition source and identifying flame boundaries (July, 1996). Although not flammable per the above criteria at atmospheric pressure, based on other compounds with similar relative amounts of hydrogen atoms, it is expected that HFC-245fa will be combustible at higher temperatures or pressures above atmospheric.

AUTOIGNITION TEMPERATURE: 774 deg F (412 deg C) Tested in 500ml flask : 1299 deg F (704 deg C) Tested in 160ml flask. In the presence of an ignition source or open flame, it may decompose to form toxic substances such as HF or COF₂.

Extinguishing Media

Use media appropriate for surrounding material.

Fire Fighting Instructions

Wear self-contained breathing apparatus. Wear full protective equipment.

ACCIDENTAL RELEASE MEASURES

Safeguards (Personnel)

NOTE: Review FIRE FIGHTING MEASURES and HANDLING (PERSONNEL)

sections before proceeding with clean-up. Use appropriate

PERSONAL PROTECTIVE EQUIPMENT during clean-up.

Evacuate personnel, thoroughly ventilate area, use self-contained breathing apparatus. Remove source of heat, sparks, and flame.

Spill Clean Up

Soak up with sawdust, sand, oil dry or other absorbent material.

HANDLING AND STORAGE

Handling (Personnel)

Do not breathe vapor or mist. Do not get in eyes, on skin or clothing. Do not store or consume food, drink or tobacco in areas where they may become contaminated with this material. Wash thoroughly after handling. Storage

Keep away from heat, sparks and flames. Keep container tightly closed.

EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls

Use only with adequate ventilation.

Personal Protective Equipment

EYE/FACE PROTECTION

Wear safety glasses, or where splash potential exists wear chemical splash goggles.

RESPIRATORS

Where the potential exists for airborne exposure, wear NIOSH approved respiratory protection.

PROTECTIVE CLOTHING

Where there is potential for skin contact, have available and wear as appropriate impervious gloves, apron or smock.

Exposure Guidelines

Exposure Limits

HFC-245fa

WEEL (AIHA) : 300 ppm, 8 Hr. TWA

Exposure Guideline Comments

Another company has established a provisional exposure limit of 500 ppm (8-hour TWA).

PHYSICAL AND CHEMICAL PROPERTIES

Physical Data

Boiling Point : 15 C (59 F)

Solubility in Water: Nil

1.9 g/L @ ambient room temp.

pH: Neutral

Form: Liquid.

Liquid Density: 1.32 g/cm³ @ 20 C (68 F)

Odor: Faint, Ethereal.

Freezing Point: -160 C (-256 F)

Vapor Density : >1.0 (Air=1.0)

4.6 (Air=1.0)

Specific Gravity: 1.32 (Water=1.0) @ 20 C (68 F)

Evaporation Rate : >1.0

Vapor Pressure: 17.8 psia @ 20 C (68 F)

56.3 psia @ 54.4 C (129.9 F)

% Volatiles: 100 % @ 20 C (68 F)

Color: clear, water white.

STABILITY AND REACTIVITY

Chemical Stability:

Stable at normal temperatures and storage conditions.

Incompatibility with Other Materials

Incompatible with strong Lewis acids such as aluminum Trichloride particularly at elevated temperatures.

Incompatible with strong reducing agents such as alkali metals (lithium, sodium, potassium), alkaline-earth metals (magnesium, calcium), or powdered aluminum or zinc.

Incompatible with strong bases such as sodium or potassium hydroxide.

Decomposition:

Decomposition: Strong Lewis acids such as aluminum trichloride could cause this compound to eliminate HF or undergo Cl/F exchange. Strong reducing agents could decompose this compound with the evolution of large amounts of heat. Strong bases at elevated temperature could form an

unsaturated compound of unknown toxicity. Decomposition Products may include: Halogens, halogen acids, and possibly carbonyl halides. These are toxic and corrosive.

Polymerization:

Polymerization will not occur.

TOXICOLOGICAL INFORMATION

Animal Data

Inhalation 4 hour LC50: >200,000 ppm in rats

Dermal LD50: >2000 mg/kg in rabbits

Single inhalation exposure to high concentrations of

HFC-245fa caused anesthetic effects, reduced response to sound, and respiratory effects. These effects occurred during exposure but not were present after the animals were removed from exposure to HFC-245fa. Cardiac sensitization did not occur in dogs exposed to concentrations up to 20,000 ppm. Repeated inhalation studies in rats caused clinical chemical and hematological changes. In a 90-day study cardiac effects occurred in rats exposed to 10,000 and 50,000 ppm. There were no cardiac effects at lower exposure concentrations of 500 and 2000 ppm.

No animal data are available to define carcinogenicity or the reproductive hazards of HFC-245fa. Animal testing indicates that HFC-245fa did not cause developmental effects. Tests have shown that HFC-245fa did not cause genetic damage in bacterial or mammalian cell cultures.

ECOLOGICAL INFORMATION

Ecotoxicological Information

AQUATIC TOXICITY:

96 hour LC50 - Rainbow trout: >81.8 mg/L.

48 hour EC50 - Daphnia magna: >97.9 mg/L

DISPOSAL CONSIDERATIONS

Waste Disposal

Treatment, storage, transportation, and disposal must be in accordance with applicable Federal, State/Provincial, and Local regulations.

TRANSPORTATION INFORMATION

Shipping Information

Not Regulated as a hazardous material by DOT, IMO, or IATA.

REGULATORY INFORMATION

U.S. Federal Regulations

1, 1, 1, 3, 3-Pentafluoropropane not listed on the TSCA public inventory. If absent from the Master inventory use only for applications excluded or exempted from TSCA.

OTHER INFORMATION

The data in this Material Safety Data Sheet relates only to the specific material designated herein and does not relate to use in combination with any other material or in any process.

Responsibility for MSDS : MSDS Coordinator

DuPont Fluoro products

Address: Wilmington, DE 19898

Telephone: (800) 441-7515

Indicates updated section.

This information is based upon technical information believed to be reliable. It is subject to revision as additional knowledge and experience is gained.

End of MSDS

ANNEX I Summary of Project Stakeholder Consultation of Environmental Management Framework for the Foam Sector

September 6, 2013, 09:30 AM – 12:30 PM
Department of Industrial Works

1. Introduction

The Project Stakeholder Consultation of Environmental Management Framework (EMF) for the Foam Sector under HCFC Phase out Project was organized at the Department of Industrial Works (DIW) on September 6, 2013 during 9.30 am-12.30 pm. The main objective of this consultation workshop was to present outcomes of EMF preparation and proposed mitigation measures for the conversion to alternatives to HCFC-141b in the foam sector.

There were 48 participants from concerned agencies attending in the consultation workshop. These agencies are 10 polyol suppliers/system houses, 9 foam enterprises that will be converting to cyclopentane technology, Polyurethan Group of the Federation of Thai Industries (FTI), Treaties and International Strategies Bureau of DIW, Industrial Cluster 3 Bureau of DIW, Industrial Cluster 4 Bureau of DIW, Central Office for Machinery Registration of DIW, Bangkok Fire and Rescue Department of Bangkok Metropolitan and Administration (BMA), Department of Labor Protection and Welfare and the Department of Public Works and Town & Country Planning.

2. Welcoming Remark

A warm welcome remark has been made to open the consultation meeting. The meeting encouraged participants to hear outcomes of EMF preparation and proposed mitigation measures for the conversion to alternatives in the foam sector. The meeting urged participants to provide suggestions/ recommendations based on their experiences and knowledge, to ensure that conversion to non-ozone depleting substance (ODS) technology would not have any adverse affects to the safety of the enterprises.

3. Background and Objectives

The HCFC Phase out Management Plan (HPMP) Stage I was formulated by DIW with assistance from the World Bank with the main objective to assist Thailand to comply with the Montreal Protocol HCFC phase out obligations. The Executive Committee of the Multilateral Fund has already approved in principle the grant fund of US\$ 23 million to Thailand through the World Bank to implement activities proposed under HPMP Stage I. In foam sector, HPMP Stage I will provide financial and technical assistance to approximately 131 HCFC-consuming foam enterprises to convert to non-ODS and low global warming potential (GWP) blowing agent in all applications except the spray foam sector, where there alternative is not technically available. Depending on the capacity of the enterprise and application, the proposed alternatives for HPMP stage 1 of the foam sector are hydrocarbons, water-blown and HFCs.

Given that 131 foam enterprises identified during preparation of the HPMP Stage I have not yet confirmed their participation in the project. EMF for the foam sector, which proposes mitigation measures for the conversion to selected alternative technology, has been prepared. Foam enterprise will use EMF as the reference to prepare its own Environmental Management Plan (EMP), which would be submitted as part of the sub-project proposal. Therefore, this stakeholder consultation would be a good forum to disseminate outcomes of EMF preparation

as well as to receive valuable feedbacks from the stakeholders to improve and finalize the EMF.

4. Presentation on Environmental Management Framework for the Foam Sector

The consultant presented scope and content of EMF and presented general risk assessment for foam sector and emphasized that the principle of risk minimization should be taken into the consideration for the engineering design. There are multiple causes of accidents comprising human condition, surrounding condition, equipment condition and raw material used in the process. It is essential for the foam enterprises to give attention to minimize these causes. The use of personal protective equipment (PPE) should be fully enforced during the operation of the worker.

Provisions for which all foam enterprise (regardless of selected alternative technology) must follow and comply are as follows:

- Factory Act B.E. 2535 (1992) and Ministerial Notification “Factory Fire Prevention and Control B.E. 2552 (2009)” for safety standards, fire emergency and preparedness, plant equipment and machineries, discharge, emission, and waste management;
- Building Act B.E. 2522 (1979) for building utilization and fire safety;
- Occupational Safety, Health and Environment Act B.E. 2554 (2011) and Ministerial Regulation “Establishment Standard of Safety, Health and Working Environmental Management System for Fire Prevention and Control B.E. 2555 (2012) for workplace, safety, health and environment, plant equipment and machineries, fire emergency and preparedness;
- Ministerial Regulation “Occupation Safety, Health and Environmental Standards for Electrical System B.E. 2554 (2011)” for electrical system inspection and maintenance;

For foam enterprises converting to cyclopentane, there are additional provisions set forth by the concerned ministries as follows:

- Ministry Notification “Storage of Hazardous Substances” and “Chemical and Hazardous Substance Manual” established and announced by the Department of Industrial Works B.E. 2550 (2007) for storage facility design and construction for cyclopentane and requirement to appoint a competent personnel to be responsible for ensuring safety of storage, handling and use of hazardous substances;
- Ministerial Regulation “Construction of other type of structure that is classified as a building” for permission for construction of storage tank size 100 cu.m. or larger;
- Decision of the Hazardous Substances Committee “Land Transportation of Hazardous Substances B.E. 2555 (2012).” for requirement for transportation of cyclopentane;

From due diligent survey, there is no serious safety issue for large foam enterprises. The consultant, however, proposed that there are rooms for various sizes of foam enterprises to improve the working condition from the safety point of view i.e. improvement of good housekeeping to prevent the practice that put fire hazard chemical and material in the same place, design of plant lay-out and set up of appropriate working space. The foam enterprise that will convert to cyclopentane technology should improve these working conditions including installation of additional safety device i.e. explosion-proof equipment, detection and alarm system and ventilation system in the potential areas for conversion to cyclopentane technology. These measures will have to be included in its individual EMP.

The consultant educated the participants on characteristics of cyclopentane. It can be easily detected by smelling, insoluble, separate at the surface of water the same as oil. It can cause eye irritation. The importance of converting to cyclopentane is to aware of the backfire to the

storage tank or foaming area due to the leakage to drainage system and reach smoker. There is need to avoid to have ignited source that could trigger fire in hazard area. Grounding and bonding and avoid the hot work in the same area as foam injection area, and put explosion proof equipment in place are a must.

The consultant explained about the flash point and flammable limit and exposure limit. The consultant suggested informing fire fighting officers about the raw material/chemical use in the foam factories. Firefighting officers/police should know the compatibility group of chemicals for effectively fire controlling. Flashback of fire from smoker through the drainage system to leaked storage tank or charging area or foam injection area need to be controlled. The template of EMP, which is the check list of measures for the foam enterprises converting to cyclopentane, was presented to the stakeholders.

For smaller size enterprises that will convert to non-flammable (water blown or HFC-245fa) technology, these enterprises do not need to prepare an EMP, but are required to update and follow their Standard Operating Procedures (SOP) and need to be complied with Thai Law and regulations. It is important to take into account the impact of other raw materials to worker health, for example, health impact from iso-cyanate.

The proposed mitigation measures for foam enterprises converting to alternative technology were presented to the stakeholders. Zoning classification of the working area was explained to the stakeholders.

5. Comments Received

The stakeholders supported the findings from the preparation of EMF including mitigation measures for the foam sector. Participants expressed the following recommendations/suggestions to improve the EMF:

- The final EMF for the foam sector should separate mitigation measures for different types of alternative technologies i.e. flammable foam blowing agent (cyclopentane) and non-flammable foam blowing agent (water-blown technology and HFC-245fa);
- Cyclopentane is not classified as hazardous substances under the Hazardous Substances Act B.E. 2535. However, the Ministry of Industry has issued the Chemical and Hazardous Substance Manual, which includes cyclopentane. Moreover, Decision of the Hazardous Substances Committee on Land Transportation of Hazardous Substances B.E. 2555 also covers transportation of cyclopentane;
- The stakeholder suggested the consultant to re-investigate whether storage of cyclopentane in the tank must comply with the regulations issued by the Excise Department. If so, this provision shall be included in the final EMF;
- Design of plant layout is important and should take it seriously to avoid fire hazard. There is need to understand how the zoning area classification is determined in particular zone 0 and zone 1 in order to select proper equipment suitable to use in each zone;
- Training and awareness need to be conducted for plant workers and fire fighting offices. This should be part of the conversion process to cyclopentane;
- Cyclopentane has been used by the manufacturers of domestic refrigerator for long period. The project proponent proposed DIW to cooperate with these manufacturers to organize a site visit to allow the enterprises to understand the plant layout and safety measures put in place for the use of cyclopentane as foam blowing agent. This would be benefits for the enterprises to have better idea and understand how to convert their production process to this technology;

- The enterprises need support from concerned parties to help provide necessary information so that the enterprise can make insightful decision on alternative technology. The project proponent requested the World Bank to provide technical advice regarding criteria for selection of alternative technology for foam blowing agent;
- As DIW has the guideline for storage of the hazardous substances, the participants proposed DIW to organize a workshop to educate the enterprises on how to handle the cyclopentane in line with the local regulations. DIW's resource person will educate the enterprises on safety in factory.

Workshop's Photo

