

## SUB-PROJECT COVER SHEET

<b>COUNTRY:</b> Thailand	<b>IMPLEMENTING AGENCY:</b> THE WORLD BANK
<b>SUB-PROJECT TITLE:</b>	<b>ABC Foam</b> – Phase-out the use of HCFC-141b and conversion to <b>cyclopentane</b> technology in the manufacture of <b>rigid polyurethane foam</b> for the production of <b>discontinuous sandwich panel</b> .
<b>SECTOR</b>	Foam
<b>SUB-SECTOR</b>	Rigid Polyurethane Foam
<b>ODS USE AT ENTERPRISE</b>	3,850[P1] ODP tonnes
<b>SUB-PROJECT IMPACT (ODS to be eliminated)</b>	3,850 [P2] ODP tonnes
<b>SUB-PROJECT DURATION</b>	1.5 years (to be completed before December 2015)
<b>TOTAL SUB-PROJECT COST</b> [P3]	
<b>Incremental Capital Cost</b>	US \$ 521,800
<b>Incremental Operating Cost</b>	US\$ 56,000
<b>Total Sub-project Cost</b>	US \$ 577,800
<b>ARTICLE 5 COUNTRY OWNERSHIP</b>	100% Thai [P4]
<b>EXPORT COMPONENT TO NON-ARTICLE 5</b>	0% [P5]
<b>REQUESTED GRANT</b>	US\$ 330,295 [P6]
<b>STATUS COUNTERPART FUNDING</b>	Letter of commitment received (Annex 1)
<b>MONITORING MILESTONES</b>	Included in document
<b>NATIONAL COORDINATING AGENCY</b>	Project Management Unit, Department of Industrial Works (DIW)

## SUB-PROJECT OF THE GOVERNMENT OF THAILAND

**ABC Foam – Phase-out the use of HCFC-141b and conversion to cyclopentane technology in the manufacture of rigid polyurethane foam for the production of discontinuous sandwich panel**

### 1. OBJECTIVE

The objective of this sub-project is to phase out the use of HCFC-141b in the manufacture of rigid polyurethane foam for the production of discontinuous sandwich panel at ABC Foam Co., Ltd. locating in Samutprakarn, Thailand.

### 2. ENTERPRISE BASELINE INFORMATION

#### 2.1 Enterprise's Background

*Name of Enterprise:* ABC Foam Co., Ltd.

*Address:* Office: ....., Bangkok, 10250  
 Factory: ....., Samutprakarn, 10280

GPS Location of Factory:[P7] Latitude xxxx  
 Longitude xxxxx

*Location of Factory:* Isolated area [P8]

*Type of Business:* Manufacturer of discontinuous sandwich panel

*Year of Establishment:* January 17, 2000 [P9]

*Number of Employees:* 100 employees

*Article 5 country Ownership:* 100% Thai [P10]

*Export Component to non-Article 5:* 0% [P11]

*Contact Person:* Mr. ABC DEFG

*Telephone:* +662 777 7777

*Fax:* +662 777 8888

*E-mail:* abc@abcfoam.com

*Website:* <http://www.abcfoam.com/>

**2.2 Annual Production Level and Consumption**

Year	Unit Produced using HCFC-141b (Unit)	Amount of Chemical Used						Total HCFC-141b Consumption (kg)  = 1+2+3
		Pure Polyol <sup>[P12]</sup>		Locally-made Pre-blended Polyol		Imported Pre-blended Polyol <sup>[P13]</sup>		
		Amount of Polyol (kg)	HCFC-141b Consumption (kg) (1)	Amount of Polyol (kg)	HCFC-141b Consumption (kg) (2)	Amount of Polyol (kg)	HCFC-141b Consumption (kg) (3)	
2010	131,860	46,286	12,000	57,857	15,000	30,857	8,000	35,000
2011	113,023	-	-	104,143	27,000	11,571	3,000	30,000
2012	124,325	-	-	108,000	28,000	19,286	5,000	33,000

**3. SUB-PROJECT DESCRIPTION**

ABC Foam was established in January 2000. It is the manufacturer of rigid polyurethane foam for the production of discontinuous sandwich panel for cold storage and industrial buildings. Under this sub-project, ABC Foam will eliminate the use of HCFC-141b and convert to non-ODP blowing agent in its process. Having been informed of all replacement technologies, the enterprise has independently chosen cyclopentane as alternative to HCFC-141b because (i) cyclopentane is proven as successful non-ODP and negligible GWP alternative in Thailand and (ii) the enterprise’s capacity to convert to such a technology. A letter from the enterprise indicating its agreement with the proposed technology choices and commitment to conversion to a zero-ODP solution is included in this sub-project document in Annex 1.

ABC Foam was the beneficiary under the Multilateral Fund during the phaseout of CFCs. <sup>[P14]</sup>Currently, ABC Foam has 3 high pressure foam injection machines in its operation for the 3 production lines. Two of which were installed in 2001 and 2006 respectively and remaining one machine was installed in 2010. The first two installed units were designed for the use of HCFC-141b and thus cannot be used with cyclopentane technology without modification. Moreover, the enterprise also has ..... sets of presses, ..... sets of multidaylight presses and ..... sets of corner presses for its manufacturing process. Of which, , ..... sets of presses, ..... sets of multidaylight presses and ..... sets of corner presses were installed prior to the cut-off date on September 21, 2007.

Under this sub-project<sup>[P15]</sup>, ABC Foam will .....<sup>[P16]</sup> two high pressure foam injection machines installed in 2001 and 2006 originally designed for HCFC-141b technology to accommodate the use of cyclopentane technology. Given that these two high pressure foam injection machines were installed prior to the cut-off date on September 21, 2007, the sub-project will support the .....<sup>[P17]</sup> of these units. No funding will be provided for the unit installed in 2010, but the enterprise will use their own funds to support the cost associated with this unit. ....<sup>[P18]</sup>

Given that cyclopentane is flammable blowing agent<sup>[P19]</sup>, there is need for safety measures to ensure the safe conversion to such a technology. Under this sub-project, ABC Foam will undertake the following actions to employ safety measures under the sub-project.

- .....<sup>[P20]</sup>
- .....

The sub-project also includes technology transfer and training, as well as trials. For technology transfer, training and trials, the production of foam using the proposed alternative technology requires extensive knowledge, which should be transferred by chemical suppliers who insightfully understands the enterprise's production process, formulation needs and production constrains. Having said the above, under this sub-project, [Insert name of polyol supplier], which has supplied raw materials to the enterprise will undertake technology transfer, training and trial components. The technology transfer, training and trials will cover the followings:

- Formulation of polyol and isocyanate using **cyclopentane**;
- Production of foam with the foaming unit;
- Safe handling of polyol, pre-blended polyol and MDI;
- Safe and proper storage of chemicals used for the production;

The safety on the production of foam using **cyclopentane** will be the responsibility of foam machine supplier in transferring training and knowledge to the enterprise. **Moreover, the foam machine supplier will be responsible for safety auditing the enterprise's compliance with safety measures for the use of cyclopentane in the factory as per foam machine supplier recommendation.** Safety handling of **cyclopentane** will be the responsibility of blowing agent supplier in transferring training and knowledge to the enterprise.

### 3.1 ODS Saving and Climate Impact (Sub-project Impact)

	Baseline Consumption (Tonnes)	ODP Value	GWP Value	ODP x Baseline Consumption (ODP Tonnes)	GWP x Baseline Consumption (tCO <sub>2e</sub> )
HCFC-141b[P21]	35.00	0.11	780	3.850	27,300.0
Cyclopentane[P22]	21.00	0	15	0	315.0
<b>Total ODP Weighted Savings and Climate Impact</b>				<b>3.850</b>	<b>26,985</b>

GWP of HC = 15, HFC-245fa = 1,030, water-blown = 0

### 3.2 Disposal Plan of Baseline Equipment

The existing baseline equipment for the production of foam at **ABC Foam** is shown in Annex 2 of the sub-project proposal. After installation and commissioning of equipment, completion of technology transfer and testing & trials and production start-up of foam using alternative technology, **ABC Foam** will dispose its baseline equipment in accordance with disposal method indicated in Annex 2. The disposal of baseline equipment will be conducted in the presence of representatives from the Department of Industrials Works (DIW) and the Government Savings Bank (GSB).

The disposal plan of baseline equipment proposed and signed by **ABC Foam** is provided in Annex 2 of the sub-project proposal.

#### 4. ENVIRONMENTAL MANAGEMENT PLAN (EMP)

The enterprise has recognized potential implications attributed to the use of hydrocarbon that may have adverse effects to safety of the workers and plant as well as negative impact to environment. The enterprise agrees to implement necessary measures to comply with the Environmental Management Plan (EMP), which is included as Annex 3 of this sub-project proposal.

#### 5. SUB-PROJECT COST

##### 5.1 Calculation of Incremental Capital Cost (ICC)<sup>[P23]</sup>

	Item	Proposed by Enterprise			Proposed Procurement Method*
		Unit Cost (\$US)	Quantity	Sub-total (\$US)	
<b>1</b>	<b><i>Foaming Unit and Pre-mixing Unit</i></b>				
1.1	Foaming machine retrofit A CMPT 100STD -2001, xx kg/min	60,000	1	60,000	??
1.2	Foaming machine retrofit A CMPT 100FC -2006, xx kg/min	60,000	1	60,000	??
1.3	Premixing unit	80,000	1	80,000	??
1.4	Polyol-pentane premixing tank - buffer tank to serve 2 foaming machines	8,000	N/A	8,000	??
1.5	Buffer tank connections Inter-connecting high pressure piping and fittings	12,000	NA	12,000	??
	<b><i>Sub-total Foaming and Pre-mixing Unit</i></b>			<b>220,000</b>	
<b>2</b>	<b><i>Storage and Safety</i></b>				
2.1	Retrofitting of xx multidaylight presses and xx corner presses to meet HC requirements	50,000	N/A	50,000	??
2.2	Ventilation system	40,000	N/A	40,000	??
2.3	Alarm and control panel	35,000	N/A	35,000	??
2.4	HC sensors 18 units, each USD1,600	1,600	18	28,800	??
2.5	Water sprinkler system for premixing room	10,000	N/A	10,000	??
2.6	Portable fire extinguishers 10 ABC 9 kg	300	10	3,000	??
2.7	Nitrogen system for blanketing the tanks and pentane storage tank	15,000	N/A	15,000	??
2.8	Emergency power generator	15,000	N/A	15,000	??
2.9	Lightning protection and grounding	2,000	N/A	2,000	??
2.10	Change of electrical installations to meet area classification	8,000	N/A	8,000	??
2.11	Hydrocarbon storage facility, underground 35 m3	55,000	N/A	55,000	??
	<b><i>Sub-total Storage and Safety</i></b>			<b>261,800</b>	
<b>3</b>	<b><i>Training and Technical Assistance</i></b>				
3.1	Technology transfer and training	20,000	N/A	20,000	

3.2	Safety certification/audit[P24]	10,000	N/A	10,000	
3.2	Testing & Trial	10,000	N/A	10,000	
	<b>Sub-total Training and TA</b>			<b>40,000</b>	
	<b>TOTAL INCREMENTAL CAPITAL COST</b>			<b>521,800</b>	

**Remark:** \* In procurement method column, please shade the cell if the procurement is not relevant for that particular item.

## 5.2 Calculation of Incremental Operating Cost (IOC)

Item	HCFC-141b system	Alternative System
	Price	Price
	(US\$/kg)	(US\$/kg)
Pure Polyols (without blowing agent)	-	Xx
HCFC-141b	-	
Cyclo-pentane		Xx
HFC-245fa		-
Pre-blended Polyol	Xxx	-
MDI	Xxx	Xxx
Foam Increase Ratio (HCFC-141b = 1)	1	Xxx
Maximum IOC Approved by ExCom (US\$)		56,000[P25]
<b>Proposed IOC (US\$)</b> <b>(Not more than Approved IOC)</b>		<b>56,000</b>

Remark: Based on the exchange rate of ..... Baht/US\$

## 5.3 Calculation of Eligible Sub-project Cost

Cost	Amount
Proposed Incremental Capital Cost (ICC)	521,800
Proposed Incremental Operating Cost (IOC)	56,000
<b>Total Sub-project Cost before Deduction(1)</b>	<b>577,800</b>
Deduction from Non-Article 5 countries Ownership and Export Component (2)	0[P26]
<b>Total Sub-project Cost after Deduction (3) = (1) – (2)</b>	<b>577,800</b>
Threshold for the Sector	9.437 \$US/kg[P27]
<b>Maximum Funding within Threshold (4)</b>	<b>330,295</b>
<b>Total Eligible Sub-project Cost (less 3 or 4)</b>	<b>330,295</b>

**6. SUB-PROJECT IMPLEMENTATION AND MONITORING [P28]**

Activity	Months from Approval of Sub-project Proposal											
	Year 1						Year2					
	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10	11 & 12	13 & 14	15 & 16	17 & 18	19 & 20	21 & 22	23 & 24
Sub-project Appraisal and Approval	X											
Signing of Sub-grant Agreement	X											
Equipment Specification and Procurement												
Equipment Delivery												
Installation of New Equipment												
Technology Transfer & Training												
Testing & Trials												
Production Start-up												
Destruction of Baseline Equipment												
Sub-project Completion Report and Approval												
Sub-project Completed												

**ANNEX 1**  
**COMPANY LETTER OF COMMITMENT**

ABC Foam Co., Ltd., represented by Mr. ABC DEFG<sup>[P29]</sup>, hereby acknowledges and commits the followings:

- a) It realizes the government policy to phase-out the use of HCFCs in the manufacture of foam in all applications except spray foam from January 1, 2016;
- b) It will completely phaseout the use of HCFCs and will not revert to HCFCs after its sub-project completion;
- c) It has been informed about all replacement technologies, and has independently chosen cyclopentane as alternative in the manufacture of foam;
- d) It commits to implement necessary measures to comply with the Environmental Management Plan (EMP), which is included as Annex 3;
- e) It will provide funds for items that are included in this sub-project, but are specifically excluded from funding by the Multilateral Fund for the Implementation of the Montreal Protocol (MLF) as well as items included in this sub-project and required for a successful completion but that, while eligible, exceed the available budget and contingencies;
- f) It will allow monitoring inspections by the Department of Industrial Works, the Government Savings Bank, the World Bank, representatives of the Multilateral Fund or their designates during implementation and after completion of the sub-project to verify proper implementation and subsequent operation without the use of HCFCs;
- g) It will dispose of baseline equipment in accordance with the disposal plan in Annex 2 in the presence of representatives from the Department of Industrial Works and the Government Savings Bank. It will inform date of disposal to the Department of Industrial Works and the Government Savings Bank in advance.

Date: 29 June 2014

Authorized Signature .....

(Mr. ABC DEFG<sup>[P30]</sup>)

Witness .....

(.....)

Witness .....

(.....)



**ANNEX 2  
DISPOSAL PLAN OF BASELINE EQUIPMENT**

ABC Foam Co., Ltd's existing baseline equipment for the production of rigid polyurethane foam for the production of discontinuous sandwich panel for cold storage and industrial buildings are summarized in table below:

No	Equipment	Unit	Equipment Information				Disposal Plan	
			Brand Name	Model	Serial Number	Year of Installation	Method	Planned Date of Disposal
1	Foaming machine # 1, xx kg/min	1	Cannon	A CMPT 100 STD	123456	2001	Retrofit	n/a
2	Foaming machine # 2, xx kg/min	1	Cannon	A CMPT 100FC	234567	2006	Retrofit	n/a
3	Foaming machine # 3, xx kg/min	1	Cannon	A CMPT 200 FC PB	345678	2010	Retrofit	n/a
4	Jigs and molds	??	XX	XX	XX	XX	XX	XX
5	Manni press 2 + 2 (temperature control)	??	XX	XX	XX	XX	XX	XX
6	Multidaylight 4m x 4m	??	XX	XX	XX	XX	XX	XX
7	Press Mold	??	XX	XX	XX	XX	XX	XX
8	Manual Press	??	XX	XX	XX	XX	XX	XX

Date: 29 June 2014

Authorized Signature .....

(Mr. ABC DEFG<sub>[P31]</sub>)

Witness .....

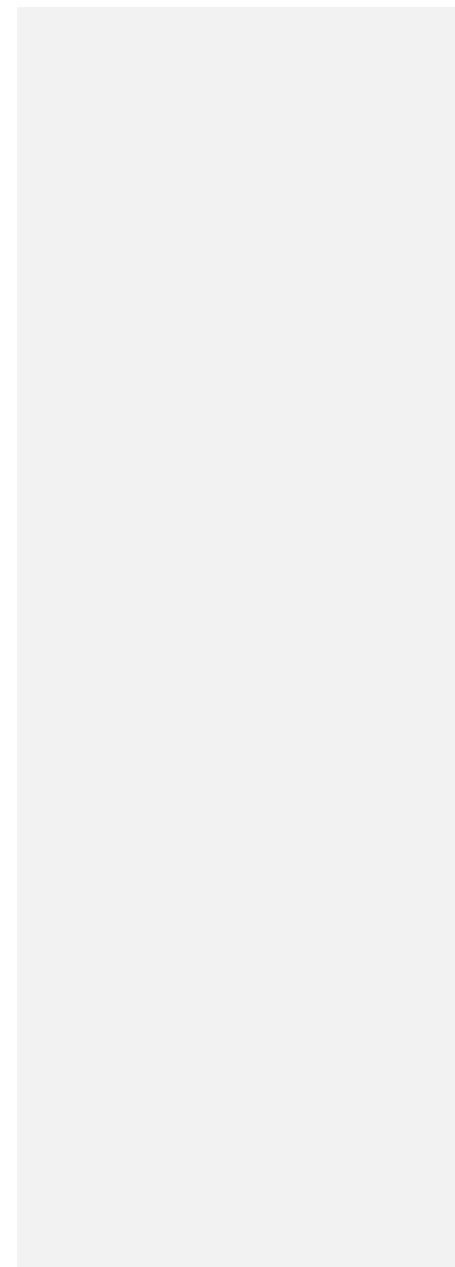
(.....)

HPMP Stage I-Foam Sector Sub-project Proposal

ABC Foam

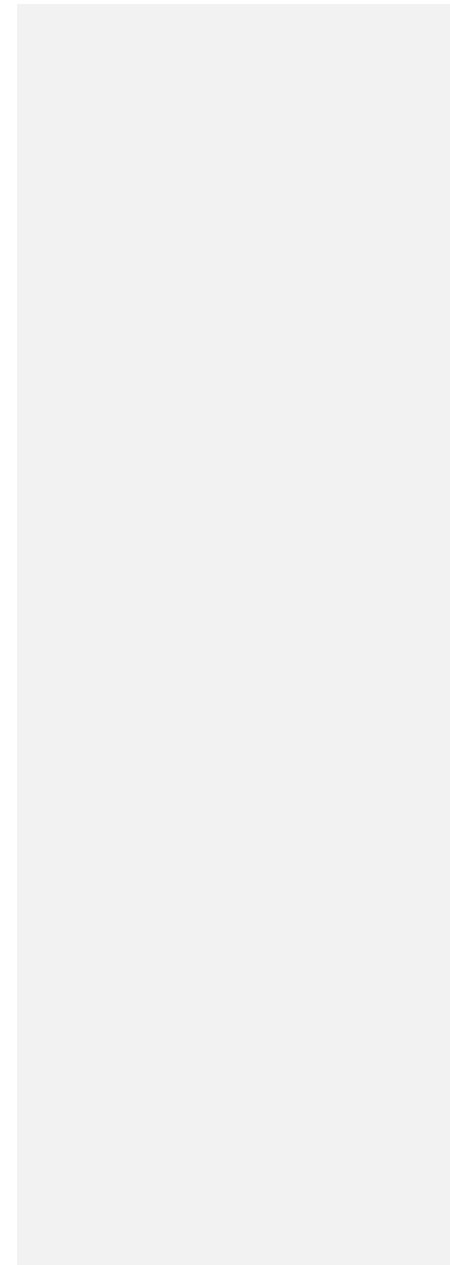
Witness .....

(.....)



**DISPOSAL PLAN OF BASELINE EQUIPMENT**

*[PLEASE INSERT PICTURES WITH INFORMATION OF NAME, BRAND NAME AND MODEL OF ALL BASELINE EQUIPMENT LISTED IN THE TABLE]*



**ANNEX 3**  
**ENVIRONMENTAL MANAGEMENT PLAN**

**Instructions:**

The EMP template below contains a section on general information and a checklist for “Cyclo-pentane delivered by tank trucks and stored in tanks” / for “Cyclo-pentane delivered in drums”. [P32]

During or promptly after the conversion process, “the checklist of safety measure for conversion to Cyclo-pentane” must be completed by the safety officer 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:	ABC Foam Co., Ltd.		
Address:	....., Samutprakarn, 10280		
Contact person:	Mr. ABC DEFG	Tel: +662 777 7777	
		Email: abc@abcfoam.com	
Location:[P33]	Residential zone		
	Commercial zone		
	Industrial zone		
	Isolated zone		X
	Mixed (please indicate the relevant zone)		
Number of employee	100 employees		

<b>Brief description of the company and its production:[P34]</b>
ABC Foam was established in January 2000. It is the manufacturer of rigid polyurethane foam for the production of discontinuous sandwich panel for cold storage and industrial buildings. Under this sub-project, ABC Foam will eliminate the use of HCFC-141b and convert to non-ODP blowing agent in its process. Having been informed of all replacement technologies, the enterprise has independently chosen cyclopentane as alternative to HCFC-141b because (i) cyclopentane is proven as successful non-ODP and negligible GWP alternative in Thailand and (ii) the enterprise’s capacity to convert to such a technology.

<b>Baseline information:</b>						
Foaming equipment	Unit 1:	Cannon A CMPT 100 STD -2001				
	Unit 2:	Cannon A CMPT 100FC -2006				
	Unit 3:	Cannon A CMPT 200 -2010				
	Unit 4:	-				
	Unit 5:	-				
HCFC-141b consumption (kg)[P35]	2010	35,000 kg	2011:	30,000 kg	2012:	33,000 kg

<b>Environmental and health characteristic of the alternative selected</b>			
Parameter	Values	Risk identified	Measures proposed
Flammability	Highly flammable (3)	Fire hazard and explosion	See actions required in Table 1 and monitoring plan in Table 3.  Pre-startup must be implemented and recorded as per template in this EMP.

<b>Approvals by relevant authorities[P36]</b>		
Authorities	Item/	Date
Department of Industrial Works (DIW)	Factory license	Xxx
	Storage of Cyclo-pentane. Max CP Amount	
	Fire safety plan	

<b>Attachments[P37]</b>	
Map showing location of factory and surroundings	Attachment 1
Floor plan foam production area	Attachment 2
Plan showing location of CP storage area/tank	Attachment 3
Standard Operating Procedures (SOP) after conversion	Attachment 4

**CONVERSION TO CYCLO-PENTANE DELIVERED BY TANK TRUCK AND STORED IN STORAGE TANK**<sup>[P38]</sup>

**Table 1: 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	National requirement for storage of CP.  DIW Notification on Storage of Chemical and Hazardous Substances B.E. 2550  The Notification of Ministry of Finance Subject Defined characteristic of Hydrocarbon Solvent B.E. 2552  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  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;	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 Thailand 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

Components / area	National requirements	Safety measures
		installation and wiring). Electrical installations in the area consistent with ex-area classification. Grounding of foaming equipment and jigs. Ventilation system with design capacity (m3/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.
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.

**Table 2: Check list of safety measure for conversion to Cyclo-pentane delivered by tank truck and stored in storage tank**

<b>Components / area</b>	<b>National requirements</b>	<b>Safety measures</b>	<b>Complied / Implemented</b>
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 (m3/h) as specified by equipment supplier installed.	
		CP Gas Detection System installed.	
		CP Gas detectors installed.	
		Nitrogen system installed.	
		Firefighting equipment	



Components / area	National requirements	Safety measures	Complied / Implemented
		installed.	
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.	

**Table 3: 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 in Table 7	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 EMP (Table 2)	Within one year after commissioning of equipment	Safety officer of enterprises
Post-commissioning audit	Within one year after commissioning of equipment and after submission of report on implementation of EMP	DIW

Note:

1. Original copy of item 7 must be sent to PMU during or promptly after the conversion process.

2. All other monitoring records are to be maintained at the enterprise facility and made available for PMU and the World Bank supervision upon request.

**CONVERSION TO CYCLO-PENTANE AND DELIVERY OF CYCLO-PENTANE IN DRUMS**[P39]

**Table 1: Proposed Safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums**

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

Components / area	National requirements	Safety measures
		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.

**Table 2: Check list of safety measure for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums**

<b>Components / area</b>	<b>National requirements</b>	<b>Safety measures</b>	<b>Complied / Implemented</b>
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.	
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.	

<b>Components / area</b>	<b>National requirements</b>	<b>Safety measures</b>	<b>Complied / Implemented</b>
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.	
		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.	

**Table 3: Environment Monitoring Plan for conversion to Cyclo-pentane and delivery of Cyclo-pentane in drums**

<b>Indicators</b>	<b>Schedule</b>	<b>Responsible party/person</b>
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"> <li>• Cyclo-pentane drum safety inspection records;</li> <li>• Cyclo-pentane drum storage area inspection records.</li> </ul>	2 times / year	Safety officer of enterprises
Pre-start up inspection using Pre-startup check list in Table 7	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 EMP (Table 5)	Within one year after commissioning of equipment	Safety officer of enterprises
Post-commissioning audit	Within one year after commissioning of equipment and after submission of report on implementation of EMP	DIW

Note:

1. Original copy of item 8 must be sent to PMU during or promptly after the conversion process.
2. All other monitoring records are to be maintained at the enterprise facility and made available for PMU and the World Bank supervision upon request.

**Pre-startup Checklist**<sup>[P40]</sup>

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 of leak, no rain water in side.			
8. Electrical installation meeting codes			
9. Gas sensor installed and operational			
10. PPE is available and used			
11. Leak detection installed (Only required for underground tanks)  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.			
12. Two 9 kg ABC portable fire extinguishers  Using 9 kg ABC fire extinguishers to fight a small fire on			



REQUIREMENTS	Compliance with requirements		COMMENTS /ACTIONS
	Y	N	
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.			
13. Connection to the pre-mixer meeting requirements			
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.			
15. Gas detection and alarm system are functioning/ tested and recorded			
16. Water hydrant readily available			
17. All concerned workers are well trained			

