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# PTT Chemical Public Company Limited (PTTCH), Thailand

**Country:** Thailand

**ISO member body:** Thai Industrial Standards Institute (TISI)

**Project team:**

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**ISO Central Secretariat advisor:** Reinhard Weissinger

**Duration of the study:** October 2010 – February 2011

## **5.1 Objectives and structure of the pilot project**

The Thai Industrial Standards Institute (TISI), a member body of ISO, was selected to participate in the ISO pilot project and has chosen a company from the chemical industry sector, PTT Chemical Public Limited, as the object of the assessment. The project team has been set up and is composed of the members of TISI and one external consultant.

## **5.2 Introduction of the selected company**

The petrochemical business is important for Thailand's economic development since it is a downstream industry which supports sustainable development and produces products used in the four key sectors of housing, food, clothing and medicine. Moreover, petrochemical products provide the raw materials essential for manufacturing consumer products, and the means and facilities to enable convenient living.

PTT Chemical Public Company Limited (PTTCH), which is a leading petrochemical company in Thailand, operates broadly across the chemical sector with its main products being olefins and shared facilities, polymers and ethylene oxide-based performance products. In addition, the company also produces oleochemical products as well as jetty and petrochemical buffer tank farm facilities in order to support the activities of the PTT Group. Most of the company's products have been certified in conformity with product and management system standards.

In this respect, PTTCH is determined to improve the living standards of the Thai people. It is the company's commitment to contributing to the country by developing and adding value to the national resources, reducing imports, generating jobs and income, and ex-

tending technology and innovation competence to help upgrade the country's human resources to meet international standards. Consequently, the company has been selected by TISI for assessment within the ISO project.

### **Business assessment**

TISI and PTTCH have discussed the pilot project aimed at assessing the economic benefits of standards, and have selected the company's polymer products to be the object of the assessment.

Polymers, as finished petrochemical products, are used as synthetic plastics to serve the other process industries, and the packaging, electric appliances and construction industries, etc. PTTCH polymer products include the following :

1. High density polyethylene (HDPE)
2. Low density polyethylene (LDPE)
3. Linear low density polyethylene (LLDPE)
4. Polystyrene (PS)

The assessment in this report is focused on the HDPE plant which has a capacity of 300 000 tons per year. Another plant operated by its subsidiary Bangkok Polyethylene Plc. (BPE) has an annual capacity of 500 000 tons. The products from the two plants are distributed under the brand "InnoPlus". In this case study, the HDPE Plant that was assessed is referred to as "HDPE I-1".

The HDPE I-1 plant uses process technology purchased from Mitsui Chemical Inc., Japan. It is capable of producing HDPE, making the conversion to end-products via the processes of blown film, cast film, pipeline, injection and thread. Quality requirements can be adjusted to fit specifications for the production of plastic bags, drinking water bottles, milk bottles, oil containers, home appliances, toys, construction materials, as well as industrial and agricultural implements

like ropes, fishing nets, nets, plastic boxes, showcases, water pipes, electrical wire pipes, etc.

HDPE is distributed to local and international industrial plants via PTT Polymer Marketing Co., Ltd. (PTTPM) which handles marketing and distribution activities for the group, to strengthen marketing competitiveness in domestic and overseas markets.

### **Company Information**

PTT Chemicals was established in December 2005 and has over 1 360 employees. It has the following production divisions :

- Olefins and shared facilities
- Polymer products value centre
- EO-based performance products value centre
- Oleochemical products value centre
- Services and others

Its annual production capacities are :

- Ethylene 1 276 000 tons
- Propylene 437 000 tons
- Total potential olefins output per year 1 713 000 tons

The company also produces :

- Mixed-C4s
- Pyrolysis gasoline
- Cracker bottom tailgas
- Hydrogen

Company operations are organized at its Bangkok headquarters and in branches situated in the industrial district of Rayong, located about 180 km southeast of Bangkok.

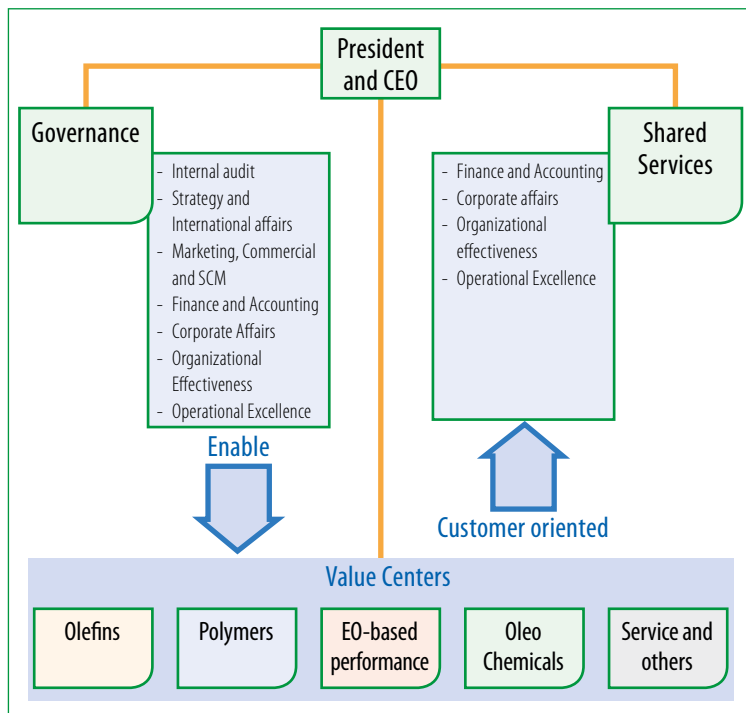
Polyethylene is a product which PTTCH manufactures for the process industry. It is used to produce equipment and plastic resins used in

daily life, thus supporting the development of the national economy. This has resulted in the reduction of imports of plastic resins from abroad. On the other hand, through its exports, PTTCH is able to contribute to the national income and to increase the efficiency of the Thai economy.

Most PTTCH customers are factories participating in the petrochemical process industries such as packaging, electrical appliances, motor parts, and textiles. PTT PM manages marketing and distribution through over 30 appointed domestic distributors and more than 120 appointed distributors covering all regions of the world. Moreover, distributors, in particular in China and Viet Nam, strongly support the management in their target markets and contribute to increased efficiency in distribution and in leveraging opportunities for greater PTTCH productivity throughout these markets.

### **Organizational structure of PTT Chemical**

PTT Chemical is organized in five value centres covering the different products, and two centralized services for governance and shared services, as shown in **Figure 1**. Governance and shared services are at the corporate centre and serve the five value centres.



**Figure 1** Organizational structure

### 5.3 Attitude of the company towards standardization

The petrochemical industry is categorized into three main segments, i.e. **upstream industry**, **intermediate industry** and **downstream industry**. Each industry category is large and has high costs since production and factory construction use costly advanced technology. In general, the management of the petrochemical industry has been involved in production processes that involve certain risks with chemical reactions, and associated activities that can be dangerous to health and the environment. If an accident occurs that disrupts

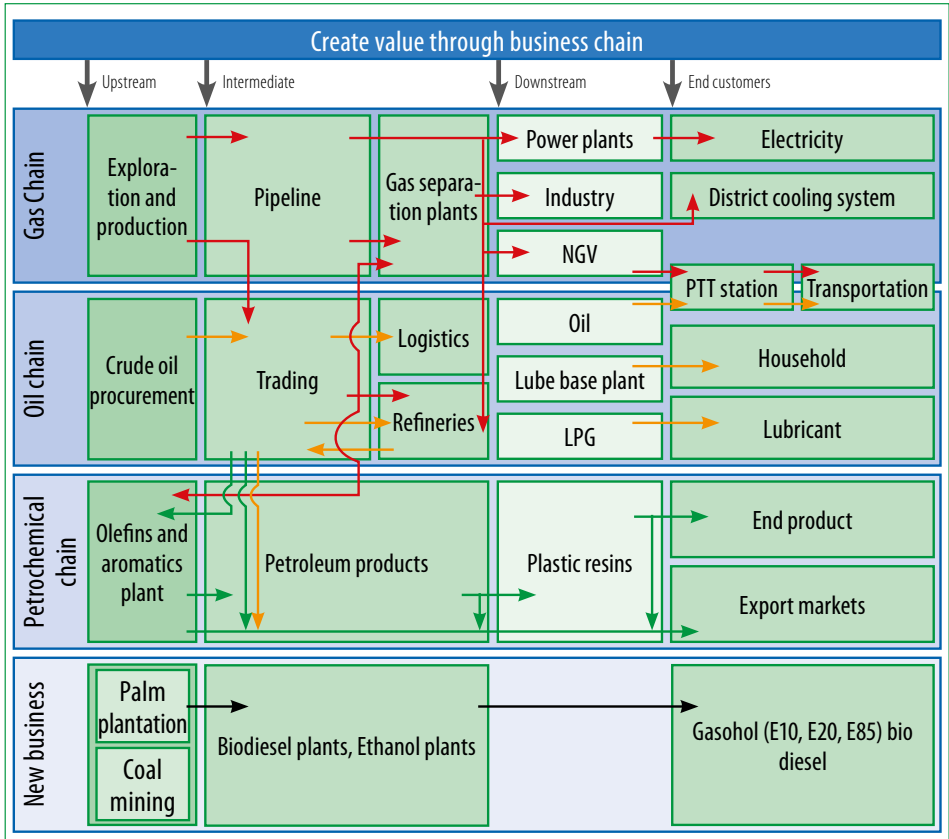
production processes and results in environmental damage, there can be major losses that may also have a long-lasting impact on the company image. Therefore, PTTCH has made it a core part of its policy to apply management system standards such as ISO 9001, ISO 14001 and OHSAS/TIS 18001 rigorously in order to institute a systematic management approach as well as to reduce occupational health, safety and environmental hazards. In addition, PTTCH emphasizes the importance of product quality and applies product standards that are intended to create and maintain customer confidence. The HDPE I-1 plant applies product and management system standards.

## 5.4 Analysis of the value chain

### 5.4.1 Industry value chain

The **upstream petrochemical industry** transforms natural gas such as ethane, propane, liquid petroleum and fuel products into raw material to supply feedstock for the intermediate petrochemical industry. The **intermediate petrochemical industry** transforms the upstream products into raw material for manufacturing intermediates and transfers them to the downstream industry. The **downstream industry** transforms upstream and intermediate products into plastic resins and synthetic fibres which are the fundamental raw materials for process industries such as packaging, electrical appliances, motor parts and textile etc.

The petrochemical industry value chain is shown in **Figure 2** below:

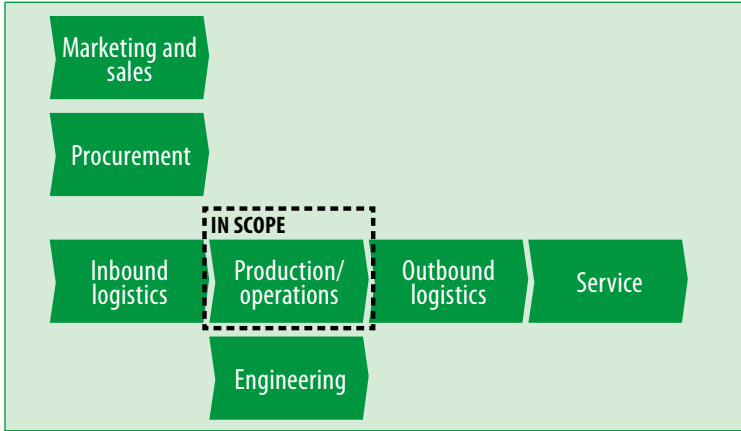


**Figure 2** Petrochemical industry value chain

PTTCH is a fully-integrated petrochemical manufacturer covering the whole value chain from the upstream to the downstream segment. Production starts from the olefins-shared facilities business, with upstream petrochemical and related supply feedstock such as ethylene and propylene. It continues with the intermediate ethylene oxide-based performance products value centre business with specialty chemicals such as ethylene oxide (EO) and ethylene glycol (EG), choline chloride, ethanolamine and Intoxiccate, etc. The final business is



the downstream polymer products value centre, producing polymers, the fundamental raw materials of many industries. Moreover, PTTCH's oleochemical products value centre bio-based chemicals fully support energy conservation and offers environmentally-friendly products.



**Figure 3** HDPE I-1 plant – Company value chain (with scope of assessment)

### 5.4.2 HDPE I-1 plant value chain

As stated in Section 5.2, the scope of this case study is limited to the downstream petrochemical industry, and focuses on the production of high density polyethylene (HDPE), the core activity of the HDPE I-1 plant. The reason for this selection is that, from the beginning, the company introduced production and operational indicators that can be used to assess the economic benefits of standards.

The details of the HDPE I-1 plant's value chain are as follows :

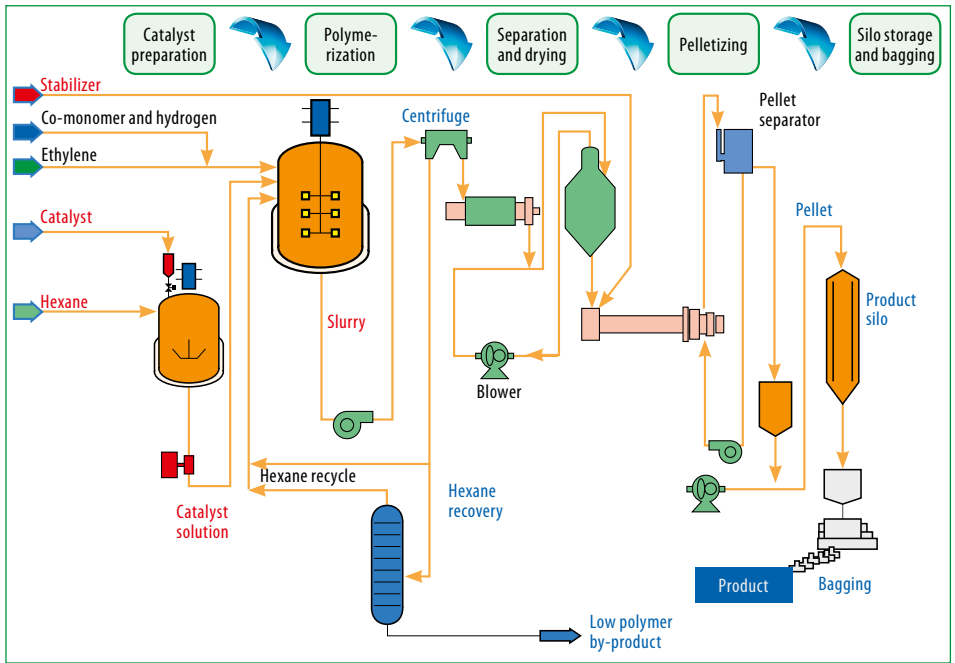
The value chain is driven by orders from customers to PTT Polymer Marketing Co., Ltd (PTTPM), a marketing agent and distributor of polymer products for the PTT Group. PTTPM collects customer orders and customer specifications and communicates these to the planning department. It transfers then the raw materials to the quality instru-

ment unit and to the HDPE I-1 production unit. The plant covers the complete process through to packaging and storage. The effective placement of polymer products is inspected by the technical unit during the process. Before packaging and storage, the products will be tested and checked before they are transferred to PTTPM for distribution.

### 5.4.3 Key value drivers

PTT Chem (HDPE I-1)		
Value drivers	Description	Source
Focused value chain coverage	Focus on operator skills in the production process	PTT Chem (HDPE I-1)
Quality of the production process	Ability to minimize failure rates in production	PTT Chem (HDPE I-1)
Product quality	Ability to create high quality products	PTT Chem (HDPE I-1)
Efficiency of production	Ability to optimize production processes in terms of process time and costs	(PTT Chem (HDPE I-1)

**Table 1** Key value drivers of the HDPE I-1 plant



**Figure 4** HDPE I-1 process flow

## 5.5 Scope of the pilot project assessment

In this case study, the HDPE production was selected for assessing the economic benefits of standards. The project covers the production and operation from planning, production and quality control to laboratory testing. Standards related to product, technology and management systems are applied at each process stage, enabling us to assess their benefits to the company. As mentioned in Section 5.4.2, we selected HDPE because manufacturing is the core operation of the company. Since the beginning of its operations in 2005 certain production process indicators have been applied. These will also be used to assess the economic benefits of standards (see Sections 5.7 and 5.8 of this report).

It should be noted that the report does not cover the assessment of suppliers nor the quality of their inputs. The reason is that raw materials testing is completed by the suppliers before the materials are delivered, so the plant relies on the correctness of such tests. The olefin plant adheres to ISO standards and is part of PTCH, and minor raw materials are already subjected to random testing by the internal PTCH laboratory.

## 5.6 Use of standards by the company

The HDPE I-1 plant applies the following standards throughout its operations.

### 5.6.1 Product standards and similar requirements

The HDPE I-1 plant implements product standards recognised in domestic and international markets. The company has certified its products against the standards listed below :

No.	Product standards	Year of certification
1	TIS 816:1995, Polyethylene resin	2007
2	US FDA 21 Code of Federal Regulations part 177.1520, test for PE, PP or olefin copolymers) (Revised 1 April, 2010)	2006
3	RoHS Directive 2002/95/EC (Directive of the European Commission on the Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment)	2006
4	European Standard EN 71:1994 + A1:2000 + AC:2002, Safety of toys – Part 3 : <i>Migration of certain elements</i>	2008
5	DIN 10955:1983, (revised 2003) <i>Sensory Analysis - Testing of Packaging Materials and Packages for Foodstuffs</i>	2009

**Table 2** Main product standards

### 5.6.2 Process Standards

In recent years product competition has been on the increase at the international level. This relates in particular to efficiency of production, which cannot be expressed simply through the quality of the product. To increase efficiency, the company follows the approach of continual improvement in efficient management by applying the following International Standards in the HDPE I-1 plant:

No.	Process standards	Year of certification
1	ISO 9001:2000, <i>Quality management systems – Requirements</i>	2006
2	ISO 14001:2004, <i>Environmental management systems - Requirements with guidance for use</i>	2009
3	TIS 18001:1999, <i>Occupational health and safety management systems</i>	2009
4	OHSAS 18001:1999, <i>Occupational health and safety management systems -- Specification</i>	2009
5	ISO/IEC 17025:2005, <i>General requirements for the competence of testing and calibration laboratories</i>	2006

**Table 3** Main process standards

### 5.6.3 Engineering Standards

As explained in Section 5.2, the process technology for the manufacturing of HDPE has been purchased from Mitsui Chemical Inc., Japan. The complete design of the plant, including the construction and the process technology, has been developed by Mitsui and is used unchanged. The “Mitsui technology” and PTT Chem engineering knowhow applies engineering standards extensively (mainly standards of ASTM, ASME, AWS and some other standards organizations). Engineering standards are particularly relevant to the organization of production and company processes in accordance with scientific criteria for the monitoring and measuring of company operations.

## 5.7 Selection of operational indicators to measure the economic impacts of standards

Several indicators have been defined in order to assess the success of the plastic resin production process at HDPE I-1. Four key indicators are used in our assessment which relate to standards, and are applied to the production process. These four indicators are defined below:

**Plant reliability:** This indicator measures the stability and reliability of the operation of the plant by comparing actual production with the nameplate production capacity (the production capacity as stated by the equipment manufacturer).

**Off specification:** The amount of product that does not comply with specification. This is calculated as the prime production as a percentage of total polyethylene (PE) production:

$$\text{Off spec. ratio (\%)} = \frac{100 \text{ Prime production (Ton)}}{\text{Total PE production (Ton)}}$$

**Ethylene consumption:** Ethylene consumption is calculated using the equation below:

$$\text{Ethylene consumption} = \frac{\text{Ethylene (Ton)}}{\text{PE actual (Ton)}}$$

**Energy index:** This indicator measures the usage of energy in polyethylene (PE) production. If this indicator is low, the energy consumption during the polyethylene production process is low. The equation is:

$$\text{Energy index (Mwh/Ton)} = \frac{\text{Net energy (Mwh)}}{\text{PE actual (Ton)}}$$

A production quality management manual has been prepared for the plastic resin production process in accordance with ISO 9001 specifying the quality management system as the fundamental guideline for good manufacturing practice.

Data on core processes, related processes and any relevant criteria have been established to enable higher efficiency. In addition, the HDPE I-1 production plan and criteria such as production quantity versus machinery capacity, the amount of off spec, in and out of planning, shut-down periods, the quantity of each raw material used, energy consumption, etc., have been clearly established.

The plant reviews these indicators every year to further improve efficiency and effectiveness. In this respect, the indicators explained above, i.e. plant reliability, off spec., ethylene consumption and the energy index, have been selected by the TISI project team as the means of assessing the economic benefits of standards. If these indicators have not been specified in accordance with ISO 9001 in the quality manual, the production process does therefore not comply with the specified planning.

## **5.8** Aggregated impacts and economic benefits of standards

The calculation of the economic benefits of standards for the four indicators is based on a comparison of 2005 data — the year the plant first implemented the standards — and 2009 data to demonstrate the increase in benefits obtained.

Selected business function	Operational indicators	Financial impact of standards on the whole business function (in 2010 prices - million USD)
Production/operation	Plant reliability	4.6
	Off specification	0.3
	Ethylene consumption	1.7
	Energy saving	2.8
	<b>Total:</b>	<b>9.4</b>

**Table 4** Financial impact of standards

The contribution of standards as a percentage of total HDPE I-1 sales revenues or turnover is approximately **3 %**.

## **5.9** Qualitative and semi-quantitative considerations

An important additional indicator in this case study is the saving resulting from reduced need for laboratory testing. However, it has been impossible to calculate the impacts for this indicator since no data have been recorded. The PTTCH testing service centre, which achieved ISO/IEC 17025 certification, conducts laboratory tests and is responsible for the inspection of raw materials used in manufacturing, including the quality of several HDPE I-1 products. Plastic resin produced by the plant is also tested and monitored. The benefits from meeting the requirements of the ISO/IEC laboratory testing and calibration standard can be seen in high and consistent product quality and customer confidence. This results in cost and time savings due to a reduced need for repeated tests for manufacturers and customers. It demonstrates how the standards generate economic benefits and provide guidance for further plant improvements.



## 5.10 Evaluation of results

In this study we were unable to compare the situation before and after the introduction of standards. The reason is that the standards have been used since the beginning of the operation of the plant in 2005. Moreover, the HDPE I-1 plant has proactively introduced management system standards such as ISO 9001, ISO 14001, TIS 18001, OHSAS 18001 and ISO/IEC 17025 as a framework for its manufacturing operations. The combined effect of management system standards and engineering standards “built-in” to the company and Mitsui technology, has been to raise the plant to a level of performance indicated by improvements in the four key indicators. Without consistent use and a management approach based on these standards, such an improvement would not have been possible. An impact from standards of 3 % of the sales revenue can be considered significant. In addition, the standards provide a framework for management and plant operation and can therefore be regarded as the “glue” that keeps the different operations and systems of the plant together.

This case study also demonstrates how the ISO methodology can be applied in a specific and flexible way. A flexible approach is required when a company has used standards from the outset, making it impossible to compare empirical data collected “before and after” the introduction of standards.

As the authors of this study, TISI suggests that reports resulting from case studies in other countries be provided to enable a comparison between the findings and the specific conditions of the companies under assessment.

## 5.11 Conclusions

To assess the economic benefits of standards for PTTCH, TISI selected the production and operations of the HDPE I-1 plant as the subject of its study. The four indicators: plant reliability, off specification, ethylene consumption and energy index, were chosen to assess the impacts of standards. The reason for this selection is that the plant collects regular data for these indicators, and it was possible to relate that information to the systematic use of standards at the management, technical and engineering levels.

After 2006, the plant systematically conformed to ISO 9000 as an administrative and management guideline resulting in increased manufacturing output and reduced use of ethylene and energy. In addition, the plant has published a quality production manual used as a basis for planning, raw material provision, and monitoring and testing of the material before manufacture, which is also followed by its suppliers. It controls production via a high-performance control system and can identify product that does not meet specification through measurements and product tests. The manual also provides guidance on the function of every unit, and helps to improve the ability of employees to control the production processes and achieve cost and time reductions, while reaching higher levels of efficiency. TISI is currently discussing the possibility of cooperation in similar projects with other companies in Thailand with a view to extending the pilot project undertaken with PTT Chemical.