

Environmental Performance Evaluation of a Rubber Glove Manufacturing Company: A Case Study¹

Nordin Abd Kadir Bakti* and Lim Kwee Shyan**

An environmental performance evaluation (EPE) of a rubber glove manufacturing company was carried out. The company chosen for this case study is a small sized company that does not have an environmental management system (EMS) – a typical example for the rubber glove manufacturing industry in Malaysia. ISO 14031:1999 was used to guide on conducting the EPE that follows a “Plan-Do-Check-Act” management model. The company attempted to reflect the relationship between the indicators for EPE and the company’s environmental performance criteria. After six months of starting the EPE, the company reviewed the indicators and modified several of the indicators to improve the EPE process. The company recognized the need for EPE as an internal environmental management tool and in general the need for the company to embark on an EMS following the ISO 14001 system to maintain competitiveness in its industry.

There is a worldwide awareness to improve the quality of the environment. A series of international standards have been or are being established to provide guidance on managing the environment¹. ISO 14000 series being prepared by the International Organization for Standardization (ISO) is one such effort. ISO 14000 series of standards were formulated in an effort to harmonize environmental management for organizations all over the world. Although the implementation of the standards is voluntary, companies that export their products are expected to implement the ISO 14000 series of standards in order to maintain their competitive edge in the global market place. Rubber glove manufacturing companies in Malaysia, which generally export their products, should take advantage of the standards as they could benefit from the implementation of the standards through improved production efficiency and new market potential.

One of the standards under the ISO 14000 series is ISO/FDIS 14031 which is in the final draft form². ISO 14031 defines the environmental performance evaluation (EPE) process for management systems. Under the ISO 14000 series, the EPE is a critical support tool that helps companies measure whether they have met their environmental performance criteria. ISO 14031 may be used independently from the other ISO 14000 series of standards and may also be used by an organization which does not have an environmental management system. It should be noted that ISO 14031 does not establish environmental performance levels and is not intended for use as a specification standard for certification. However, it supports the requirements in ISO 14001 and the guidance in ISO 14004 and thus its implementation is essential to companies with an environmental performance management in place.

A case study on the EPE of a natural rubber glove manufacturing company was carried out to illustrate how EPE may be applied by companies, in particular the small and medium sized enterprises, which manufacture natural rubber gloves. This case study may be useful to some 100 odd natural rubber glove manufacturing companies in Malaysia where they collectively are responsible for meeting about 75% of the global requirement for natural rubber gloves³.

This paper is based on a report⁴ of an example selected by Technical Committee ISO/TC 207 Subcommittee SC 4 for inclusion in the ISO technical report TR 14032 at its 11th meeting held in Kuala Lumpur on 10 to 13 December 1998. Besides incorporating the example, this paper further elaborates the section on reviewing and improving EPE.

¹ Paper presented at the EPE Workshop, 7th meeting of ISO/TC 207, Seoul, Korea, May 29 – June 6, 1999

* Rubber Research Institute of Malaysia, P.O. Box 10150, 50908 Kuala Lumpur, Malaysia.

** General Manager, Perusahaan Pelindung Getah (M) Sdn Bhd., Senawang Industrial Estate, Negeri Sembilan, Malaysia.

INTRODUCTION TO PERUSAHAAN PELINDUNG GETAH (M) SDN. BHD.

Perusahaan Pelindung Getah (M) Sdn. Bhd. (PPGM) is a small private limited company established in 1988 and located in the state of Negeri sembilan, Malaysia. The PPGM factory is located upstream from a public water supply intake which consequently requires it to comply with stringent effluent standards. The total number of employees at PPGM is approximately 100. The factory has three production lines which operate 24 hours per day, for 312 days each year. The factory produces approximately 8 million pieces of medical examination gloves per month, most of which are exported to the United States of America.

The company used a natural rubber latex concentrate with 60% dry rubber content preserved with 0.7% ammonia on latex by weight. A latex compound is prepared by adding chemicals to the latex in a sequence of batch operations. The additives include fatty acid soap (stabiliser), sulphur (cross-linking agent), zinc dibutyldithiocarbamate (accelerator), zinc oxide (activator), alkylated phenols (anti-oxidant) and titanium dioxide (pigment). After mixing with the chemicals, the latex is left to mature for one day before its utilisation in glove manufacturing.

The manufacturing process uses the coagulant dipping technique and an automatic chain drive system. The dipping process begins with cleaning of the porcelain formers and finishes with stripping of the gloves from the formers. Although the technology adopted for glove manufacturing is widely used by latex glove manufacturers since it is practical and has low operating costs, environmental considerations had not been fully incorporated in the design resulting in significant environmental concerns.

In the manufacturing process, heated ceramic formers are first dipped into a slurry of calcium nitrate and calcium carbonate. When the formers are sufficiently dried, they are dipped into the latex compound. The calcium nitrate on the former causes the latex compound to coagulate over the formers thereby taking their shape. The calcium carbonate provides an anti-tack barrier between the rubber and the formers thus facilitating the subsequent removal of the finished gloves.

Leaching with water is used to remove the water-soluble substances coated to the newly formed gloves. On some of the lines, a post leaching has been added as it helps to further reduce the water-extractable protein on the surface of the gloves. Effluent from the leaching tanks is one of the main sources of water pollution.

The occurrence of residual soluble proteins in latex gloves has the potential to cause allergic reactions in sensitised individuals. The post leaching carried out at the factory is a measure to minimise this problem.

The wastewater from the PPGM factory is treated on site in an effluent treatment plant utilising a chemical flocculation, anaerobic digestion and activated sludge process. Hazardous chemical sludge containing zinc is produced. Legislation requires the company to collect, transport, treat and finally dispose off the sludge to a central treatment facility. The company is also required to treat its effluent to comply with the existing regulatory standards. The effluent standards with which the company is expected to comply are that the zinc concentration in the final discharge be less than 1 milligram per litre and Chemical Oxygen Demand (COD) is to be less than 50 milligrams per litre.

This example concentrates on starting an EPE process. PPGM does not have an environmental policy and no environmental management system is in place, but the management of PPGM has agreed to evaluate its environmental performance following the principles of ISO 14031. In this example, the company is attempting to reflect the relationship between the indicators for EPE and the company's environmental performance criteria.

PLANNING EPE

The management of PPGM decided to plan their EPE based on the environmental aspects related to the company's activities, the views of selected interested parties and some selected environmental performance criteria. The important environmental aspects of the company's products and activities were identified as indicated in *Table 1*.

TABLE 1. IMPORTANT ENVIRONMENTAL ASPECTS OF PPGM

Product/Activity	Environmental Aspect	Potential Impact/Effect
Rubber glove	<ul style="list-style-type: none"> Disposal of rejected gloves (i.e. those not meeting product specifications). 	<ul style="list-style-type: none"> Soil and ground water contamination through land application and air pollution through open burning.
Latex compounding	<ul style="list-style-type: none"> Addition of chemicals (e.g. stabilisers, curatives, protecting agents, pigments, defoamers) in latex compounding. Discharge of residual latex containing toxic chemicals. Mixing of ammonia-preserved latex in open tanks and emission of ammonia vapour. Addition of sulphur powder during latex compounding and emission of sulphur dust. Washing of latex mixing and storage tanks and generation of hazardous liquid waste containing high concentrations of zinc and COD. 	<ul style="list-style-type: none"> Soil and ground water contamination through land application. Water pollution. Health-related problems for workers.
Leaching of gloves with water	<ul style="list-style-type: none"> Discharge of effluent from leaching tanks and generation of hazardous liquid waste containing high concentrates of zinc and COD. 	<ul style="list-style-type: none"> Water pollution

After reviewing public statements, minutes of meetings and discussions with interested parties, the important interested parties were identified as indicated in *Table 2*.

TABLE 2. THE VIEWS OF INTERESTED PARTIES

Interested Parties	Expected Views
Department of the Environment	<ul style="list-style-type: none"> Treated effluent shall comply with regulatory requirements.
Export market (e.g. U.S.A. Food and Drug Administration)	<ul style="list-style-type: none"> Level of extractable protein in rubber gloves shall be less than or equal to 0.3 milligram extractable protein per gram of rubber.
Public water treatment plant operator	<ul style="list-style-type: none"> Quality of river water at the intake which may be affected by the effluent discharged from the PPGM factory.
PPGM top management	<ul style="list-style-type: none"> Cost effectiveness of environmental control measures
Local community	<ul style="list-style-type: none"> PPGM's operations shall not cause any nuisance.

In the plan for development of the EPE process, the following environmental performance criteria were selected:

- Total compliance with regulation;
- Zero public complaint on its operations;
- Minimal adverse environmental effect (e.g meet ambient air quality standards);
- Maintaining the number of pieces of gloves rejected to be less than 5% of the total pieces of gloves produced, in accordance with product specification;
- Maintaining the level of extractable protein in gloves at less than or equal to 0.3 milligram extractable protein per gram of rubber.

The PPGM management plans to implement the following environmental management programs to address its environmental performance:

- Reduction of extractable protein level in gloves;
- Improvement in effluent treatment plant efficiency;
- Waste minimisation through process modification;
- Monitoring of surface water quality upstream and downstream of its factory.

SELECTING INDICATORS FOR EPE

PPGM selected indicators for EPE to provide information on management efforts, performance of its operations and the condition of the environment as a direct consequence of the implementation of environmental management programs. The management of the company has also established the objectives and targets to be achieved within a specified time-frame for each of the programs. The indicators selected are more meaningful with the establishment of these objectives. The company has also set up a project plan for each program. The project plan lists the activities to be carried out, the time frame, the resources, and the responsibilities associated with each activity. The indicators selected in relation to environmental performance criteria are presented in *Table 3*.

TABLE 3. SELECTED INDICATORS FOR EPE

Indicators for EPE	Basis for Selection of the Indicator
Management Performance Indicators (MPIs)	
<ul style="list-style-type: none"> • Annual total cost of implementing environmental programs. 	<ul style="list-style-type: none"> • For the evaluation of management commitment (i.e. useful public relations materials)
<ul style="list-style-type: none"> • Number of environmentally-related complaints received by PPGM per year. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on zero public complaint.
<ul style="list-style-type: none"> • Number of effluent samples analysed monthly not complying with regulatory standards. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on total compliance with regulations.
Operational Performance Indicators (OPIs)	
<ul style="list-style-type: none"> • Number of pieces of gloves rejected in relation to the total number of pieces of gloves produced per month. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on controlling rejects in order to reduce wastes.
<ul style="list-style-type: none"> • Extractable protein level of glove measured in milligrams of extractable protein per gram of rubber. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on eliminating the potential cause of protein allergy (This information is useful to the U.S. FDA).
<ul style="list-style-type: none"> • Quantity of zinc in kilograms discharged to the receiving watercourse per month. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on minimising wastes.
<ul style="list-style-type: none"> • COD load in kilograms discharged to the receiving watercourse per month. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on minimising wastes.
<ul style="list-style-type: none"> • Quantity of dried sludge on kilograms produced per month. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on minimising wastes.
Environmental Condition Indicators (ECIs)	
<ul style="list-style-type: none"> • Incidence of protein allergy associated with the use of rubber gloves by sensitised individuals (i.e. number of official reports per year). 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on eliminating the potential cause of protein allergy.
<ul style="list-style-type: none"> • Changes in the quality of surface water upstream and downstream of the factory's effluent discharge point. This indicator is based on the test for inhibition of oxygen consumption by activated sludge as carried out in accordance with the ISO 8192 procedure. The specific indicator is the percentage of change in EC 50 value where EC 50 is defined as the concentration which inhibits the oxygen consumption by 50%. 	<ul style="list-style-type: none"> • For evaluation against the environmental performance criterion on ensuring the environment is not adversely affected by PPGM's operations (This information will be useful to the water treatment plant operator).

USING DATA AND INFORMATION

Some of the indicators require raw data collection on a regular basis, analysis of the collected data and conversion of the data into indicators. For example, the indicator on the quantity of zinc discharged to a watercourse per month requires regular measurements of effluent flow rates and zinc concentrations in the effluent. The PPGM management uses a commercial software to enable the collected data to be stored and managed. The computer software has the capability to display the analysed data in a graphical form and to show the trend of the various indicators with time. The information can be incorporated in a report, prepared using a word processor, for communication to interested parties on a regular basis. The information is made accessible over the Internet at <http://www.gloves.com.my/environment.htm>.

REVIEWING AND IMPROVING EPE

After six months of starting the EPE, the PPGM management reviewed the indicators and decided to modify several of the indicators in order for the EPE to be more effective. These changes are summarised in *Table 4*.

TABLE 4. IMPROVED INDICATORS FOR EPE

Old Indicators	New Indicators
<ul style="list-style-type: none"> • Number of effluent samples analysed monthly not complying with regulatory standards. 	<ul style="list-style-type: none"> • Percentage of effluent samples analysed monthly complying with regulatory standard for BOD. • Percentage of effluent samples analysed monthly complying with regulatory standard for COD. • Percentage of effluent samples analysed monthly complying with regulatory standard for suspended solids. • Percentage of effluent samples analysed monthly complying with regulatory standard for zinc.
<ul style="list-style-type: none"> • Number of pieces of gloves rejected in relation to the total number of pieces of gloves produced per month. 	<ul style="list-style-type: none"> • Percentage of gloves produced per month that are defective.

PPGM considered the revised indicators in *Table 4* on the compliance to the regulatory standards to be better than the existing indicator as these indicators are more specific and address the major parameters of concern.

Although it was not intended in this paper to give a full report on the results of the EPE process at PPGM, *Figure 1* may illustrate the usefulness of the new indicators discussed above. *Figure 1* shows the percentage of effluent samples analysed monthly complying with the regulatory standard for BOD. These indicators are considered useful in providing focus for PPGM to work on in improving its wastewater treatment plant.

For the indicator on the number of pieces of gloves rejected, PPGM considered the percentage of gloves produced per month that are defective is a better indicator. *Figure 2* shows the trend of this indicator in 1998. The company had little difficulty in meeting the environmental performance criterion of 3% for this indicator. The criterion for the percentage rejects was revised from 5% to 3%.

The water-extractable protein levels (*Figure 3*) were generally below the limit set by PPGM. On some of the occasions where the protein level seemed to exceed the limit which was attributed to water shortage, PPGM was able to overcome the problem by improving the leaching operation. For the lines without the post-leaching tank which is used to remove the water-extractable proteins, PPGM sold the gloves which did not meet the specification for extractable protein to another factory with the facility to remove the protein. PPGM is however planning to extend the post-leaching stage to all the lines to reduce the dependency on other factories to buy its off-spec gloves.

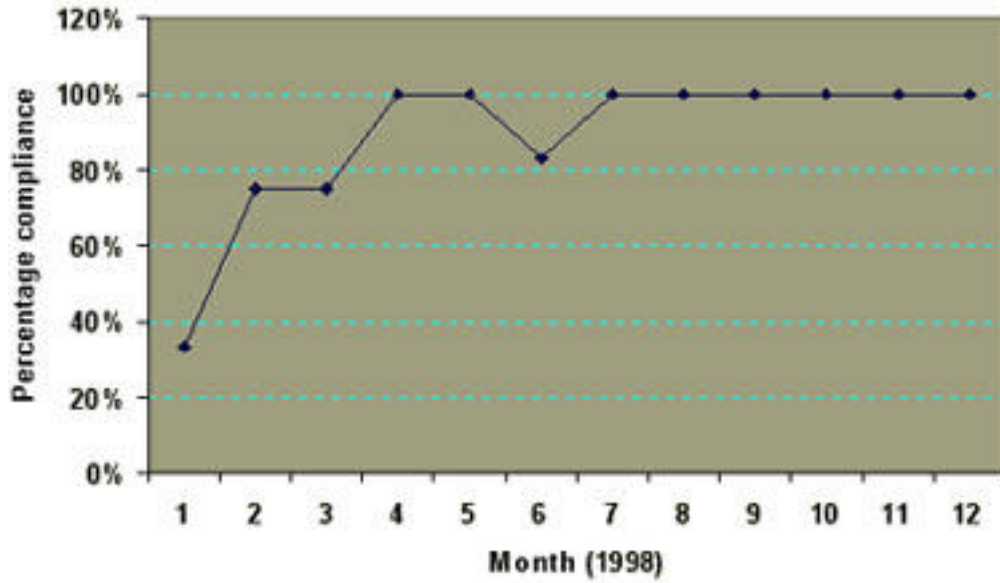


Figure 1. Percentage of effluent samples analysed monthly Complying with the regulatory standard for BOD

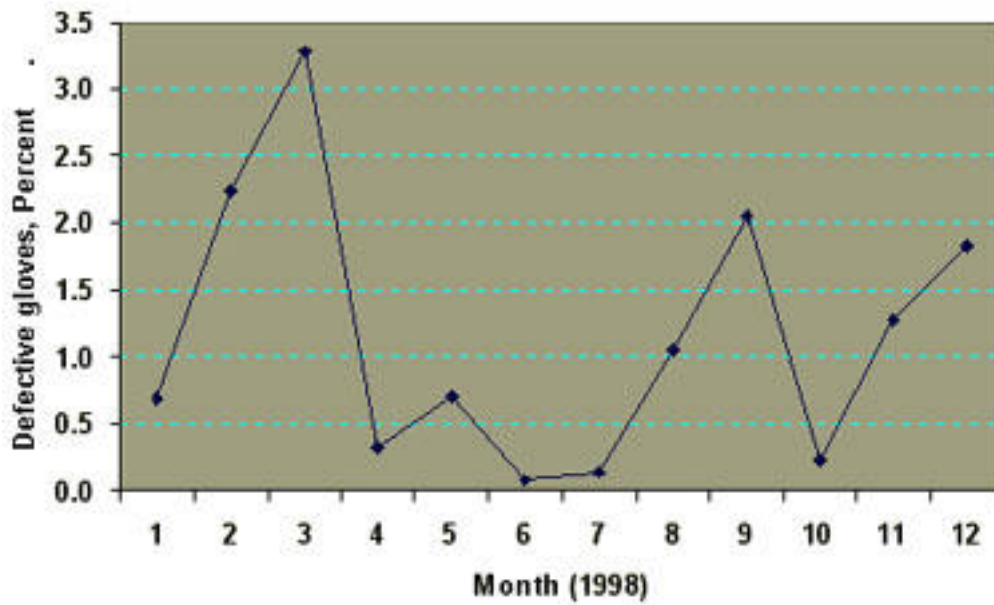


Figure 2. Percentage of gloves produced per month by PPGM that are defective

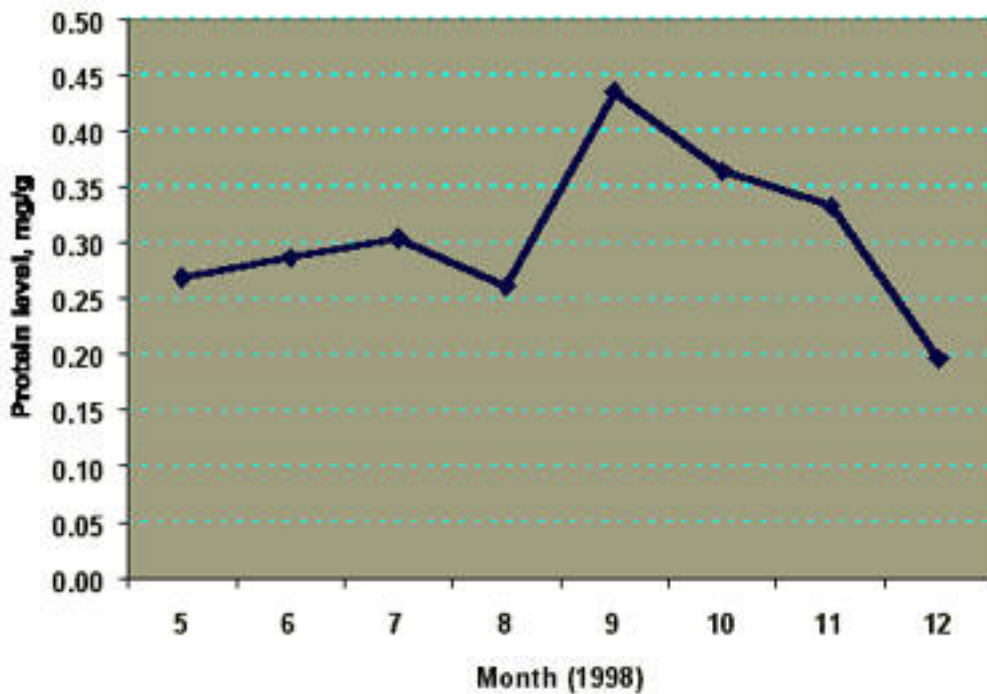


Figure 3. Water-extractable protein levels in the PPGM gloves

PPGM realised the indicators requiring the measurement of effluent flow, namely, quantity of zinc in kilograms discharged to the receiving watercourse per month and COD load in kilograms discharged to the receiving watercourse per month, were not reliable. This is because of the limitation in flow measurement but will find ways to improve on the data collection.

The indicator on annual total cost of implementing environmental programs could not be assessed because the EPE was just started. Also, PPGM did not receive any environmentally-related complaint in 1998 but this indicator would be maintained for evaluation against the environmental performance criterion on zero public complaint.

Sold wastes generated at the PPGM's factory were rejected gloves, rubber lumps, chemical and biological sludge. Rejected gloves and rubber lumps were sent to a recycling plant where the rubber wastes were converted into low-grade rubber products. PPGM is seeking the approval from the Department of Environment to send the chemical and biological sludge to a fertiliser manufacturing factory. PPGM will continue to monitor the generation of the solid wastes as one of the indicators for evaluating against the environmental performance criterion on minimising wastes.

PPGM maintained a collection of articles and reports on incidence of protein allergy associated with the use of natural rubber gloves by sensitised individuals but had not reviewed the indicators. PPGM had just started monitoring the indicator on the changes in the quality of surface water upstream and downstream of the factory's effluent discharge point and the data collected were insufficient for review.

PPGM may consider adding more indicators, for example, on the consumption of toxic chemicals, energy and water. The company's management will also consider implementing an environmental management system to improve the use of EPE in the company.

SUMMARY/CONCLUSIONS

PPGM recognises the need for EPE as an internal environmental management tool and in general the need for the company to embark on an EMS following the ISO 14001 system to maintain competitiveness in its industry.

Continuous improvement on the EPE process including changes to the indicators is inevitable as the company is fine-tuning this management tool to derive the maximum benefits from its implementation.

Although there may be some variations in natural rubber glove manufacturing from company to company, the EPE process discussed in this paper is generally applicable to the industry as a whole.

REFERENCES

¹ John C.K. (1997) ISO 14000 – An Overview. In Proceedings of the Seminar on ISO 14000 with Special Reference to Environmental Management System, RRIM Training Centre, Sungei Buloh, 6 May 1997.

² ISO/FDIS 14031 (1998) Environmental Management – Environmental Performance Evaluation – Guidelines. ISO/TC 207/SC 4 N279 Document, 35 pp.

³ Abdul Halim Hassan (1997) Current Status and Prospects of the Malaysian Latex-Based Industry. In Proceedings of the Seminar on Malaysian Latex-Based Industry – Review, Competition and Opportunities, Subang Jaya, 22 September 1997.

⁴ ISO TR 14032 (1998) Environmental Management – Environmental Performance Evaluation – Examples Illustrating the Use of ISO 14031. ISO/TC 207/SC 4 N281 Document, 85 pp.