UNEP

Responsible Production for Chemical Hazard Management

Lessons Learned from Implementation

United Nations Environment Programme

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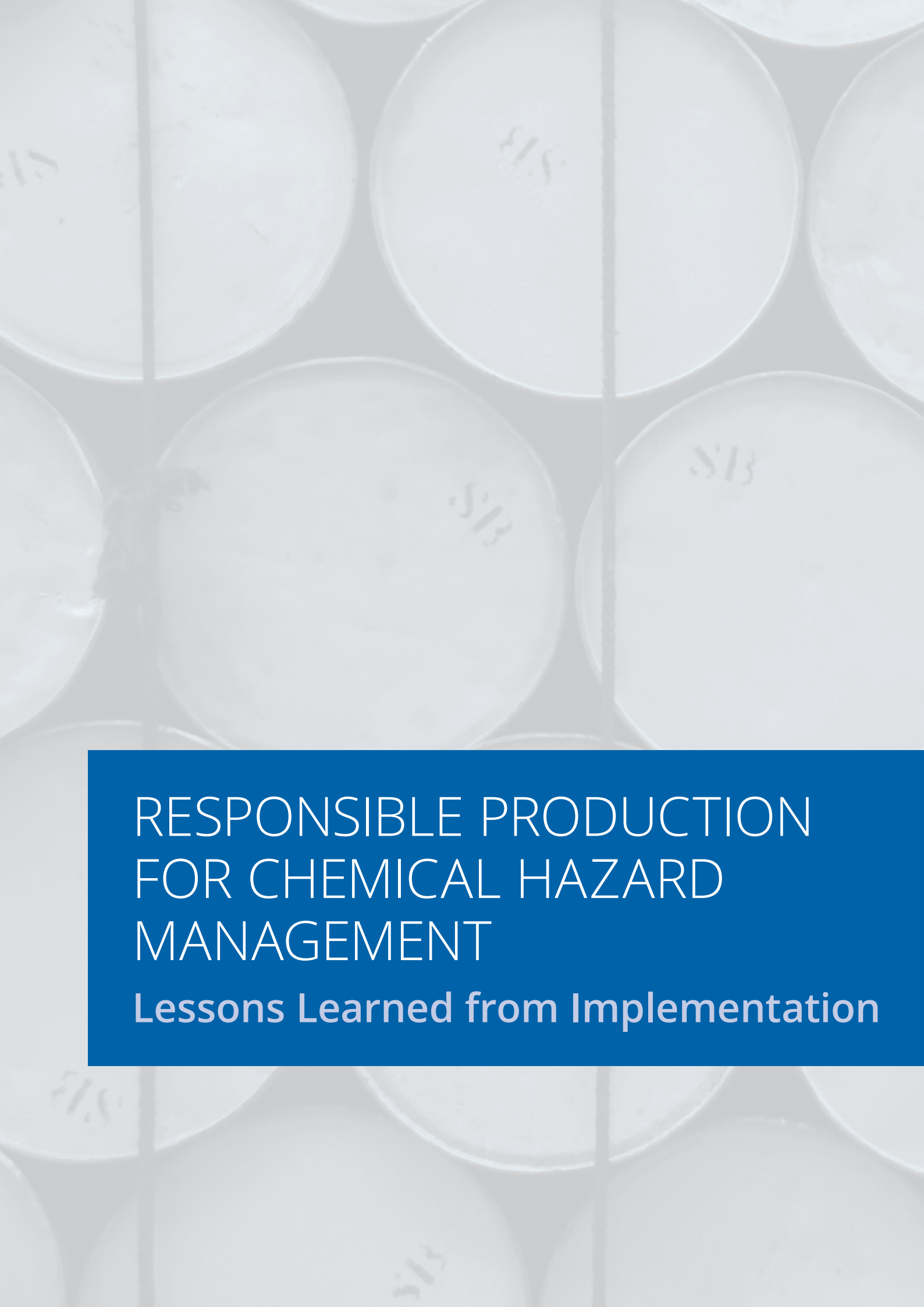

RESPONSIBLE PRODUCTION FOR CHEMICAL HAZARD MANAGEMENT

Lessons Learned from Implementation

UNEP FOREWORD

As the use of chemicals in commerce becomes more and more common, managing chemical hazards is becoming of greater importance around the world. Manufacturing processes for all sorts of products use hazardous chemicals that have the potential to harm human health or the environment in the event of a spill or accident. As value chains become more globalized involving an increasing number of small and medium sized enterprises (SMEs) in developing countries, it is imperative to engage with these enterprises and encourage them to adopt safer practices along the value chain.

However, reaching out to smaller companies is often challenging for policy makers and these businesses are often overlooked by programmes enhancing chemical safety management. The Strategic Approach to International Chemicals Management (SAICM) calls for all chemicals to be produced and used in ways that minimise the adverse impacts that these could have on human health and the environment. SAICM is endorsed at the highest political levels and by a range of international organisations, including UNEP. But, in order for it to be successful, chemical producers of all sizes and in all countries must play a role. In this context, UNEP recognises that reaching out to the small chemical producers in developing countries is essential.

In many developing countries, SMEs form the backbone of the industrial sectors where chemicals are manufactured or used. Therefore, we at UNEP consider that it is critical that SMEs develop the capacity to safely manage their risks/ hazards associated with chemicals. For a long time, UNEP has worked to support the safe production and use of hazardous substances throughout the value chain of chemical companies. This has included initiating preventative approaches, such as the "Responsible Production Handbook - A Framework for Chemical Hazard Management for Small and Medium Sized Enterprises", to encourage continuous improvement of chemical safety.

Since UNEP published the Responsible Production Handbook in 2010, we have worked with pilot SMEs in a number of countries, including Egypt, El Salvador, China, India, Sri Lanka and Thailand to apply Responsible Production principles to manage chemical risks in industry. Now we are launching this publication "Responsible Production for Chemical Hazard Management: Lessons Learned from Implementation", which documents the experiences gathered through these industrial pilot projects. This set of company success stories provides insights into the practical application of the Responsible Production Approach and aims to disseminate its principles as widely as possible.

By sharing feedback and lessons learned, UNEP hopes that international organisations, governments, technical service providers (such as National Cleaner Production Centres), Environment, Health and Safety Managers of big companies working with SMEs, insurance companies, industry associations, chambers of commerce and other stakeholders will better understand the benefits of UNEP's Responsible Production Approach and will support UNEP in reaching out to SMEs in order to improve sound chemicals management. By working together in this way we can move towards a safer industry for the benefit of all.

Arab Hoballah
Chief, Sustainable Consumption and Production (SCP) Branch
Division of Technology, Industry and Economics
United Nations Environment Programme

INTERNATIONAL COUNCIL OF CHEMICAL ASSOCIATIONS (ICCA) FOREWORD

Global chemical suppliers recognise their responsibility for safe chemical management by publically committing to Responsible Care©. The associated Global Product Strategy requires the provision of comprehensive product information, including the identification of the hazard profile in accordance with the Globally Harmonised System of Classification and Labelling of Chemicals.

This can be a difficult challenge for small and medium sized enterprises, particularly in emerging economies needing our collective help. The ICCA Responsible Care Leadership Group (RCLG) regards the Responsible Production Approach as an effective tool for addressing this challenge. It is aligned with the work that the ICCA is doing through Responsible Care through chemical associations in 65 counties.

ICCA, through the RCLG, supported UNEP in the development of the Responsible Production Handbook by sharing industry best practices. Our exciting collaboration with UNEP now continues into country activities and will progressively streamline the delivery of practical and cost effective solutions in a number of countries reflecting the Responsible Care ethic together with the UNEP goals. The result will be better outcomes through more efficient utilisation of the available expertise and resources, thereby ensuring maximum value for stakeholders.

This excellent collection of case studies is clear evidence to me of just what can be achieved. The result is very similar to what I have seen through Responsible Care; that improved environmental health and safety performance using our programmes and offerings either from UNEP or ICCA also makes very sound business sense. With our tools, SMEs achieve together even better performance to societal expectations and, at the same time, profitability improvement.

Peter Cartwright
Chairman
Responsible Care® Leadership Group
International Council of Chemical Associations

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The Responsible Production approach was developed by the United Nations Environment Programme, Division of Technology, Industry and Economics (UNEP-DTIE) and AccountAbility in cooperation with the International Council of Chemical Associations (ICCA) and the International Council on Mining and Metals (ICMM).

The *"Responsible Production for Chemical Hazard Management: Lessons Learned from Implementation"* was developed by UNEP-DTIE in collaboration with Beratungsgesellschaft für integrierte Problemlösungen (BiPRO), Asia Society for Social Improvement and Sustainable Transformation (ASSIST), Thailand Environment Institute (TEI), and the National Cleaner Production Centres (NCPCs) of China, Egypt, El Salvador, and Sri Lanka.

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EXECUTIVE SUMMARY

Responsible Production (RP) is a simple and comprehensive approach to chemical hazard management, drawing on experience from different sources to provide guidance specifically for small and medium sized enterprises (SMEs). It is designed to help companies increase the overall safety of their operations and reduce chemical emergencies by setting out a process to identify and address the hazards and risks associated with manufacturing, processing and handling of chemicals. It encourages companies to engage with their supply-chains (including suppliers, customers, distributors, and transporters) in safer production, accident prevention and emergency preparedness.

The *Responsible Production Handbook – A Framework for Chemical Hazard Management in Small and Medium Sized Enterprises* provides the model for implementing the RP approach. After the Handbook was launched in 2010, UNEP undertook a series of activities to ensure its effective adoption and use by relevant stakeholders around the world. Through numerous awareness-raising events and opportunities to introduce the concept, UNEP has been able to promote the value of the RP approach.

In addition, UNEP organised pilot projects to test the RP approach at small or medium sized companies located in China, Egypt, El Salvador, India, Sri Lanka and Thailand. These projects were conducted with the support of National Cleaner Production Centres (NCPCs) and other local technical partners as well as with additional technical support provided by UNEP and international experts. These pilot projects have provided valuable practical insights on planning and implementing Responsible Production measures.

This publication documents results, feedback, and lessons learned from the pilot projects and, based on this, presents a number of conclusions and suggestions for future activities.

The initial experiences and results derived from the pilot projects were very encouraging. The participating companies identified potential hazards and successfully implemented corresponding risk reduction and accident prevention measures. In fact, the projects show that, in many cases, initial risk reduction strategies can be realised at little or no cost. In addition, pilot projects demonstrated that implementation of Responsible Production provides synergies with similar initiatives and programmes (such as Corporate Social Responsibility and Resource Efficient and Cleaner Production).

RP proved to be flexible and adaptive, adjustable to the specifics of companies spanning various industry sectors. The pilot projects demonstrated the importance of clearly communicating the benefits of RP to senior management since their commitment is vital in effectively setting up an RP team and implementing risk reduction measures. Furthermore, it is important to have highly-trained local experts to assist the companies in capacity building and RP implementation. Working with SMEs showed that future efforts should be expanded to involving relevant stakeholders along the value chain in Responsible Production activities.

摘要

“负责任的生产”是一种简单的化学品危险管理方法，该方法是在多种不同方法的应用经验基础上开发而成，尤其适用于为中小企业提供相关指导。该方法是通过建立一套程序方法以识别并消除或降低与企业化学品的生产、加工和处理有关的危险和风险，从而帮助企业提高其经营过程中的整体安全性，并减少化学品紧急突发事故的发生。该方法促使生产企业与其供应链各方（包括供应商、客户、经销商和承运商）在更安全的生产、事故预防以及突发事件的应急准备方面加强密切合作。

《负责任的生产——中小企业化学品安全管理框架手册》为实施“负责任的生产”提供了具体技术方法。自该手册于2010年正式发布以来，联合国环境署已经启动并实施了一系列项目活动以确保其能被全球范围内众多利益相关方有效采用并实施。联合国环境署通过各种不同形式的宣传推广活动与培训研讨会介绍“负责任的生产”这一理念，使得“负责任的生产”的价值得以广泛宣传与认可。

此外，联合国环境署还在中国、埃及、萨尔瓦多、印度、斯里兰卡和泰国的中小企业组织实施了一系列试点项目，以验证“负责任的生产”方法的效果。这些试点项目都是在各国的国家清洁生产中心和当地其他技术支撑机构的支持下实施完成的，同时项目也得到了联合国环境署提供的国际技术支撑和国际专家的支持。这些试点项目为规划和实施“负责任的生产”方法提供了宝贵的实践经验。

本书介绍了这些试点项目的实施结果、反馈信息、取得的经验等，并以此为基础提出了有关结论和开展后续活动的建议。

试点项目取得的初步经验与成果是令人鼓舞的。试点企业都成功地识别了潜在的危险，实施了降低风险和预防事故的措施与方案。事实上，这些试点项目获得的经验表明在许多情况下，不花钱或是花很少的钱就可以初步降低风险。此外，试点项目的经验还表明，“负责任的生产”可以与其他类似的活动以及项目（例如环境、健康和安全项目以及企业社会责任）一同实施。通过与中小企业的合作表明，我们在将来还需要做出更多努力，帮助企业让有关的利益相关方更积极地参与到“负责任的生产”活动中。

ملخص تنفيذي

يعتبر الانتاج المسئول توجة بسيط لادارة لمخاطر المواد الكيميائية, بناء علي خبرات متراكمة ومكتسبة من مصادر مختلفة لتوفير الدعم الفنى اللازم خاصة للشركات الصغيرة والمتوسطة للوقاية من و تقليل الحوادث الكيميائية. وقد تم تصميم برنامج الانتاج المسئول لمساعدة الشركات على زيادة معدلات الأمان في عملياتهم و تقليل حالات الطوارئ للحوادث الناتجة عن التعامل مع المواد الكيماوية استناداً الي نظام يمكن من خلاله تعريف و تحديد نقاط المخاطر المتعلقة بالعمليات الصناعية والتعامل مع المواد الكيميائية. وبصفة عامة يعمل هذا البرنامج على تشجيع الشركات على المشاركة مع سلاسل التوريد الخاصة بهم (الموردين والعملاء والموزعين وشركات النقل للمواد الكيماوية) لإنتاج أكثر أماناً ومنع الحوادث والتحضير لحالات الطوارئ للحوادث الناتجة عن تداول المواد الكيميائية.

أصدر برنامج الامم المتحدة للبيئة (UNEP) فى سنة 2010 دليل الأنتاج المسئول كاطارا لإدارة مخاطر المواد الكيميائية في الشركات الصغيرة والمتوسطة والذى يقدم نموذج عملى لتطبيق برنامج الانتاج المسئول فى الشركات الصغيرة والمتوسطة.

و بعد اصدار الدليل أجرى برنامج الامم المتحدة للبيئة (UNEP) سلسلة من الأنشطة الأرشادية لضمان استخدام الدليل بطريقة فعالة وضمان استخدامه من الجهات ذات الصلة في جميع أنحاء العالم. وقد استطاع برنامج الامم المتحددة للبيئة (UNEP) تعزيز قيمة برنامج الانتاج المسئول من خلال العديد من الانشطة والفرص التي تساعد علي رفع الوعي و توضيح فكرة البرنامج.

بالإضافة لما سبق، نظم برنامج الامم المتحددة للبيئة (UNEP) مشاريع تجربية لاختبار برنامج الانتاج المسئول فى الشركات الصغيرة و المتوسطة في كل من الصين و مصر و السلفادور و الهند و سيريلانكا و تايلاند بالتعاون مع مراكز الانتاج الانظف (NCPCs) في هذه البلدان و شركاء فنيين محليين و دعم فني دولي من برنامج الامم المتحددة للبيئة (UNEP) و خبراء دوليين. وقد كان لهذه المشاريع أبلغ الأثر في تقديم رؤي عملية في تخطيط و تنفيذ اجراءات الانتاج المسئول فى المنشات الصناعية.

وفي هذا السياق فإن المنشور الحالى يوثق النتائج والملاحظات والدروس المستفادة من المشاريع التجريبية و بناءً عليه تم التوصل الي العديد من المقترحات القيمة و العملية لتخطيط وتنفيذ تدابير الإنتاج المسئول. إن النتائج الأولية المستمدة من المشاريع التجريبية كانت مشجعة للغاية و استطاعت الشركات المشاركة بنجاح تقليل الأخطار المحتملة وتم تطبيق تدابير الحد من المخاطر و منع الحوادث بنجاح.

وقد أظهر تطبيق المشاريع التجربية إنه في العديد من الحالات انه يمكن تطبيق استراتيجية الحد من المخاطر بدون أو بتكلفة قليلة للغاية. اضافة الي ما سبق, اثبتت المشاريع التجريبية ان الانتاج المسئول متناسق مع البرامج و المبادرات المتشابهة (مثل الصحة والسلامة البيئية, والمسئولية الأجتماعية للشركات). و قد أوضح العمل مع الشركات الصغيرة والمتوسطة الحاجة الملحة لبذل مجهود في المستقبل لدعم الشركات عن طريق إشراك الجهات ذات الصلة في انشطة الانتاج المسئول.

GLOSSARY ABBREVIATIONS / ACRONYMS

ACC American Chemistry Council
ADPC Asian Disaster Preparedness Center
AIChE American Institute of Chemical Engineers
APELL Awareness and Preparedness for Emergencies at Local Level (UNEP)
ASSIST Asia Society for Social Improvement and Sustainable Transformation
BiPRO Beratungsgesellschaft für integrierte Problemlösungen
BPIE Bangpoo Industrial Estate (Thailand)
CAPP Chemical Accident Prevention and Preparedness
CCPS Centre for Chemical Process Safety of the American Institute of Chemical Engineers (AIChE)
ChL Chemical Leasing
CII Confederation of Indian Industries (CII)
CNCPC China National Cleaner Production Centre
CLP Classification and Labelling of Chemicals
CP Cleaner Production
CNPML Centro Nacional De Produccin Mas Limpia de El Salvador (Cleaner Production Centre El Salvador)
CSR Corporate Social Responsibility
CT Cleaner Technology
CTA Cleaner Technology Audit
DIW Department of Industrial Works, Ministry of Industry of Thailand
DTIE Division of Technology, Industry and Economics (UNEP)
EMS Environmental Management System
ENCPC Egyptian National Cleaner Production Centre
EPA Environmental Protection Agency (US)
EHS Environment, Health and Safety
EU European Union
FAO Food and Agriculture Organization of the United Nations
FTI Chemical Industry Club of the Federation of Thai Industries
FMEA Failure Mode and Effects Analysis
GCPC Gujarat Cleaner Production Centre
GHS Globally Harmonized System of Classification and Labelling of Chemicals
GIZ German Agency for International Cooperation (Deutsche Gesellschaft für internationale Zusammenarbeit)
GPS Global Product Strategy
GTZ German Agency for Technical Cooperation (Deutsche Gesellschaft für Technische Zusammenarbeit)
HAZOP Hazard and Operability Analysis
HSE Health, Safety and Environment
ICC Indian Chemical Council
ICCA International Council of Chemical Associations
ICMM International Council on Mining and Metals
IEAT Industrial Estate Authority Thailand
ILO International Labour Organization (UN)
MCCI Madras Chambers of Commerce and Industry
MoU Memorandum of Understanding
MSDS Material Safety Data Sheet
MU Mahidol University (Thailand)
NCPC National Cleaner Production Centre
OECD Organisation for Economic Co-operation and Development
OSH Occupational Safety and Health
OSHA Occupational Safety and Health Administration (US)
PPE Personal Protective Equipment
PSM Process Safety Management
QA Quality Assessment
REACH Registration, Evaluation, Authorization and Restriction of Chemicals (EU)
RECP Resource Efficient and Cleaner Production
RERP Resource Efficient and Responsible Production
RMP Risk Management Plan (US)
ROI Return on Investment
RP Responsible Production
SAICM Strategic Approach to International Chemicals Management
SME Small and Medium Sized Enterprise
TEI Thailand Environment Institute
ToT Training of Trainers
UL MSS Underwriters Laboratories Management Systems Solutions India Pvt. Ltd.
UNDP United Nations Development Programme
UNEP United Nations Environment Programme
UNIDO United Nations Industrial Development Organization
UNITAR United Nations Institute for Training and Research
VIA VAPI Industry Association (India)
WHO World Health Organization

INTRODUCTION

1

(Source: Ulrich Müller - Fotolia.com)

OVERVIEW

This publication provides a general description of the Responsible Production (RP) approach and how it was developed to help small and medium sized enterprises (SMEs) to improve chemical safety by setting out a process for: identifying risks and hazards in the production, use and handling of chemicals; and developing appropriate risk reduction measures to address these hazards/risks.

After an overview of RP in the context of related initiatives and activities, this publication provides a brief explanation of the types of activities that have been carried out to promote the RP approach.

The focus of this publication is on the RP pilot projects, which took place in seventeen small and medium sized companies located in six countries: China, Egypt, El Salvador, India, Sri Lanka and Thailand. These pilot projects were primarily of limited duration and, therefore, focused on the initial phases of the 5 step RP process, looking at on-site operations. The pilot projects aimed to identify the most important hazards and risks, and then implement measures to reduce the likelihood and impacts of chemicals accidents. Due to the time constraints, most of the companies were not able to engage their supply chain fully in the RP process but it is expected that, in the future, the companies will expand their efforts to involve their suppliers, customers, transporters, and others in the supply chain.

This publication concludes with an overview of the feedback from the pilot projects to identify lessons learned and recommendations for future activities.

WHAT IS RESPONSIBLE PRODUCTION (RP)?

Responsible Production is a simple approach to chemical hazard management, drawing on experience from different sources[1] to provide guidance for small and medium sized enterprises to improve chemical hazard management. It is a systematic, continuous improvement approach designed to increase overall safety and reduce chemical emergencies and their environmental, social and economic impacts by helping companies identify and address the hazards and risks associated with manufacturing, processing and handling of chemical substances.

The Responsible Production approach is designed for those companies that do not have sophisticated safety management systems in place, helping the companies to understand the benefits of improved chemical hazard management and how to increase overall safety and reduce chemical emergencies through risk planning, management and communication along the value chain[2]. It brings together concepts from the following three approaches into a single, easy to use framework. These building blocks of Responsible Production can be grouped into the following three areas:

- **APELL (Awareness and Preparedness for Emergencies at Local Level)**: improved awareness of risks in communities, and integrated emergency response through multi-stakeholder participation;
- **Corporate Social Responsibility (CSR)**: improved understanding of social and environmental issues and impacts of businesses, emphasising stakeholder engagement and credible public disclosure;
- **Safer Production**: simplified process safety management, including operational and management systems, process guidance and tools.

[1] It was created by UNEP and AccountAbility, in cooperation with the International Council of Chemical Associations (ICCA) and the International Council on Mining and Metals (ICMM).

[2] The term 'value chain' refers to the successive stages during which value is created when producing, distributing, and servicing a product. The value chain typically includes: inbound logistics and material inputs; operations; outbound logistics; marketing and sales; after sales service and disposal.

Community Emergency Preparedness - the Awareness and Preparedness for Emergencies at Local Level (APELL) Programme

Launched in 1986 by UNEP, APELL is a methodological tool designed to improve chemical management and local level emergency preparedness through a community-oriented effort. It focuses on building local partnerships, bringing together industries, local authorities, and community members through a systematic 10-step multi-stakeholder process.

For purposes of Responsible Production, the APELL approach helps companies build relationships with their community, generating the confidence, trust and support which companies need in order to secure its social license to operate. Drawing on the principles of APELL, companies are provided with a way to establish an effective system of risk communication, allowing local communities to become aware of the potential risks and impacts and to be more prepared to respond correctly in the event of an accident.

Corporate Social Responsibility

CSR is a form of corporate self-regulation integrated into a business model. CSR functions as a built-in, self-regulating mechanism whereby a company monitors its legal compliance, embraces responsibility for the company's actions, and encourages a positive impact on the environment, consumers, employees, communities, and other stakeholders. Furthermore, CSR-focused businesses proactively promote the public interest by encouraging community growth and development, and by voluntarily eliminating practices that harm the public, beyond the requirements of the law. CSR is the deliberate inclusion of the public interest into corporate decision-making and the honouring of a triple bottom line: people, planet, profit[3].

CSR addresses issues related to the full range of a company's impacts, including, for example, business ethics and governance, community investment, environmental impacts due to production and product use, human rights and workplace standards. Approaching chemical hazard management from a CSR perspective would require a company to understand these issues, both strategically as well as technically.

As one of the three building blocks of Responsible Production, the core issues of CSR such as stakeholder engagement, performance disclosure, internal and external performance assurance, and transparency have been included in the RP Toolkit. The linkage between CSR and RP works both ways: improved safety of workers and the neighbourhood also contributes to a company's CSR endeavours.

[3] The CSR elements in RP are based on the Stakeholder Engagement Manual prepared by AccountAbility.

Safer Production - Process Safety Management

Several models for safer production and, in particular, Process Safety Management (PSM) have been developed generally focusing on manufacturers and users of industrial chemicals. Safer Production comprises the tools, guidelines, and management principles implemented on-site and at the local level to ensure both the safety and health of workers in facilities that manufacture, store, handle or use hazardous substances, as well as the prevention of releases of these substances into the environment. Responsible Production may be described as "simplified" PSM.

There are a number of safer production approaches, many developed by industry or professional associations such as the Centre for Chemical Process Safety (CCPS) of the American Institute of Chemical Engineers (AIChE), the American Chemistry Council (ACC), and the International Council of Chemical Associations (ICCA). All the safer production approaches share some common elements including, for example: hazard and risk assessment; process risk management; management of change; operational procedures and safe work practices; maintenance and equipment integrity; emergency preparedness and response; and involving the value chain including, for example, operations, logistics and customers.

Considering these elements as part of Responsible Production implementation helps companies understand and addresses the risks posed by their operations.

One of the most widely used methodologies related to PSM is Hazard and Operability Analysis (HAZOP)[4]. HAZOP was originally developed in the 1960s to analyse chemical processes, but has since become a useful tool for various industry sectors. It is also used to comply with regulatory requirements. As a methodology for identifying risks, HAZOP has been included in UNEP's Responsible Production Approach.

[4] In HAZOP, processes are broken down in small sections that are analysed individually, specifically focusing on potential risks that may arise due to deviations from the process "design intent". In this way, HAZOP systematically helps to identify and evaluate hazards that may lead to severe consequences with regards to the environment or human health.

(Source: iStock Photo)

WHY RESPONSIBLE PRODUCTION?

UNEP has developed a number of initiatives to help countries, communities and industries to address environmental hazards, promoting resource efficient, cleaner, safer and responsible production as well as supporting sustainable forms of business and industrial development in line with corporate environmental and social responsibility principles, policies and practices. Responsible Production focuses on SMEs in developing countries and countries with transition economies, providing technical support for chemical hazard management.

The accidental release of hazardous substances can have very serious consequences to a company and the community where it operates. An accident can kill or injure workers or members of the public; drinking water and soil contaminated with chemicals may also lead to chronic disease and other health problems. Chemical accidents can also spoil the environment and result in long-term damage to wildlife and sensitive habitats and can result in significant economic harm, not only to the company where the accident occurred, but also other companies in the vicinity and along the value chain. The costs associated with response, clean-up and recovery can be quite significant. Communities in developing countries are often at a greater risk of adverse effects from chemical accidents due to fragmented regulations or incomplete enforcement of existing rules, and/or inadequate resources for preventative approaches or preparedness for and response to accidents. Furthermore, in many of these countries land-use planning rules are not strictly enforced and residential and commercial facilities tend to be located close to industrial installations.

In addition, hazardous chemicals are moved each year around the world by road, rail and pipelines, posing risks to the communities along the routes. Prevention, preparedness and response to transport accidents involving hazardous substances are more difficult to

address than accidents at fixed installations[5]. Another concern is the unsafe storage and handling of chemicals off-site by both dealers and end users, who often do not have the proper training or knowledge regarding the risks posed by products containing hazardous chemicals and used containers.

The costs and benefits of investing in chemical safety management are not easy to quantify, taking into account the costs associated with prevention and preparedness as well as the extent of costs that are realised after an incident or accident. These include medical costs, clean-up, compensation and fines, damage to communities, property and environmental impacts. In addition to the direct impacts and costs, small businesses often overlook the costs that may threaten business continuity, including downtime due to the accident itself, lost time due to injured persons, decrease in business function, loss of customer confidence, and damage to their reputation[6].

Taking this into consideration, the voluntary Responsible Production approach is intended to complement relevant laws, in order to help control the risks that result from production, use or handling of hazardous chemicals, recognising that the increasing number of SMEs in many countries results in increasing chemical risks. Responsible Production considers the entire value chain, including raw materials supply, chemical production, transportation, storage, distribution and use as well as hazardous waste disposal.

[5] The potential for transport accidents creates special challenges with respect to, for example: identifying appropriate transport routes; choosing transport modes; preparing an adequate risk assessments and emergency preparedness plans in light of the changing nature, variety and quantities of substances on any transport route; accessing emergency response services; and informing the potentially affected public along the transport routes.

[6] National Chemical Emergency Centre. "Counting the Costs of Chemical Incidents." http://the-ncec.com. Apr. 2012. Web. 17 May 2012. http://the-ncec.com/counting-the-cost-of-chemical-incidents.

RESPONSIBLE PRODUCTION: TAILOR-MADE FOR SMEs

Industrial accidents involving hazardous chemicals occur throughout the world, not only in large operations but also in facilities operated by small and medium sized enterprises (SMEs) including facilities that may not appear to be hazardous. Such accidents can kill or harm workers and members of the public, cause damage to the environment and result in adverse impacts to property and the local economy.

SMEs face special challenges because they often have few employees, little specialised expertise related to chemical hazards and risks, and limited resources. Many SMEs in developing countries do not have emergency preparedness plans or appropriate protective equipment for their employees. An accident will negatively impact the image of a company and, especially for an SME, could put the company out of business.

These aspects highlight the need for a systematic and effective approach to improve chemical safety measures as part of a company's overall chemical management system. SMEs often lack access to appropriate tools to address chemical safety issues as most of the existing guidelines and frameworks were designed with large companies in mind.

In 2010, UNEP published the *"Responsible Production Handbook - A Framework for Chemical Hazard Management for Small and Medium Sized Enterprises"* (UNEP, 2010)[7]. UNEP's Responsible Production approach provides a framework, drawing on the best and most appropriate guidance from different sources, to promote the continuous improvement of chemical safety along the value chain. This aims to provide environmental, social and economic benefits not only to the SMEs implementing it, but also to other participants in the value chain and the surrounding communities and, in the long term, to the society.

Responsible Production builds on the work of international development agencies and institutions, industry associations, and inter-agency initiatives related to the promotion of chemical hazard management and emergency preparedness, as well as on leading CSR and product stewardship initiatives, with the ultimate aim of contributing to increasing overall chemical safety as well as reduction of environmental emergencies in the operations of SMEs and along the company's value chain.

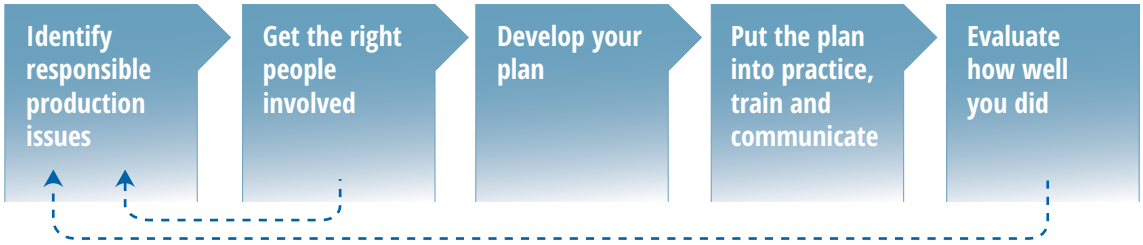
[7] Responsible Production Handbook - A Framework for Chemical Hazard Management for Small and Medium Sized Enterprises" (UNEP, 2010) is available online at: http://www.unep.org/responsibleproduction. The publication exists in Arabic, Chinese, English, French, Spanish, Thai and Vietnamese.

KEY FEATURES OF THE FIVE-STEP RESPONSIBLE PRODUCTION FRAMEWORK

The Responsible Production framework provides a step-by-step process for improving chemical hazard management. The accompanying RP Toolkit includes guidance and tools for each of the five steps, along with a set of indicators that help monitor progress at each step (see Figure 1 for an overview of the five steps).

The systematic and comprehensive approach ensures that companies from a wide variety of industrial sectors are able to adapt the Responsible Production (RP) approach to their particular situation taking into account, for example, their capacity and the scale of hazards.

Figure 1: Responsible Production Framework



Specifically, the RP framework allows companies to systematically identify chemical safety issues, and then identify a path for addressing the issues (determining what actions should be taken along with the timeframe and resources needed). The stepwise approach of Responsible Production supports companies in:

- identifying and understanding the hazards and risks related to a company's products and operations;
- identifying opportunities for reducing risk and costs;
- engaging with business partners and communities to improve safety as well as preparedness for accidents involving hazardous substances;
- promoting risk communication and product risk information along the value chain;
- training workers and business partners in chemical safety;
- improving procurement systems to include chemical safety management;
- measuring and communicating performance; and
- fulfilling requirements of relevant legislation.

The following further explains the key features of each of the five steps associated with the Responsible Production framework.

Step One – Identify Responsible Production Issues

In the first step, all significant issues regarding chemical hazards and their related risks for the company are systematically identified. Having a deeper understanding of the substances produced, used or handled by the SME and their physical and chemical properties, helps the company assess risks as well as the potential environmental and health impacts. This understanding also provides a basis for setting priorities in the development of an action plan. The RP tools provide support for identifying risks by preparing a process flow chart, a chemical inventory, and a legal register[8] and assessing the severity and frequency of risks, in order to map those risks.

Step Two – Get the Right People Involved

Cooperation with stakeholders, beyond the employees at an individual company, is crucial for business success. Transparency is the basis of mutual understanding; it helps increase customer and community confidence, attract investors, and enable better responses to customers' requests.

The RP approach aims to encourage companies to listen to the concerns and advice of relevant stakeholders as part of managing their chemical hazards in an appropriate way. RP helps an SME to systematically identify people who can be affected by its products, operations and decisions as well as people whose actions and decisions can affect the SME. RP supports constructive dialogue with both groups.

Step Three - Develop Your Plan

Careful planning with respect to measures and activities to reduce risks will significantly influence the successful outcome of implementing the RP approach and, in the long-run, a sustainable and continued chemical safety management programme. As both risks and stakeholders change over time, it is also relevant to periodically review strategies and plans.

The RP tools related to "Developing a Plan" support companies to understand the issues that require a response and how to address those through risk reduction measures. This includes understanding the costs and benefits of such measures. This will eventually help companies in setting specific, achievable goals, in order to develop appropriate plans for the implementation of measures to control chemical risks including, for example, training and emergency preparedness.

Step Four – Put the Plan into Practice, Train and Communicate

This step guides companies in putting into practice their chemical control action plans as well as related training and emergency plans. Implementing measures in a transparent manner involves informing stakeholders about the relevant activities. Once implemented, strategies need to be reviewed to identify the need for any revisions or adjustments.

With the help of the RP Handbook, it is possible for a company to discover best practice procedures for implementing planned measures and communicating these activities effectively, leading to improvements in safety performance along with improved competitiveness and reputation.

[8] A listing of all legal, code, regulatory and other requirements applicable to the company's products, processes and operations (including hazardous substances used as raw materials, additives, cleaning materials, fuels, etc.).

Step Five – Evaluate How Well You Did

The RP approach encourages any company to continuously monitor and evaluate its performance to help meet the objectives that were set in the beginning of the process and to adjust measures, as appropriate. In this context, communication and engagement with stakeholders supports continued transparency and a climate of mutual trust. The RP tools also support a company in the development of a sound communication approach which can complement an independent assessment and assurance of the company's RP-related performance.

WHO IS THIS PUBLICATION FOR?

This publication provides case studies of how the Responsible Production approach has been applied in different parts of the world since 2010, the year that the Responsible Production Handbook was published. UNEP, together with the UNEP-UNIDO[9] National Cleaner Production Centres (NCPCs) and similar technical institutions have supported a number of "on-the-ground" around the world. This publication shares the experiences of those companies, officials and experts that applied the RP approach.

The RP Handbook[10] is directed primarily at those persons who are responsible for chemical safety management in SMEs. It also recognises that, in order to establish effective internal management approaches, SMEs benefit from engaging in dialogue with their stakeholders. These stakeholders include suppliers, wholesalers, retailers, transporters, and end-users, as well as government officials and others in surrounding communities.
As explained below, this publication should be of interest to managers of SMEs that produce, use or handle hazardous substances, as well as: NCPCs and other technical service providers; industry associations; national and local authorities; insurance companies; potential donors; and international organisations. This list is not exhaustive; other groups may find the experience, feedback and lessons learned presented in this publication valuable.

SMEs that Produce, Use or Handle Hazardous Substances

RP provides managers and staff of an SME (such as a production manager, EHS personnel, the general manager or the owner) a means to systematically analyse risks related to chemicals. This comprises the company's

[9] United Nations Industrial Development Organisation
[10] Responsible Production Handbook- A Framework for Chemical Hazard Management for Small and Medium Sized Enterprises (UNEP, 2010)

operations – including the entire production process and storage, as well as auxiliary operations and temporary activities - to identify hazard hotspots, accident scenarios and possible risk prevention measures.

This publication can help relevant staff at SMEs to take advantage of experiences in the application of RP measures, as implemented by the pilot companies. Additionally, this publication shows larger companies that interacting with upstream SMEs (*e.g.*, suppliers) in a systematic way can improve the safety of their entire value chain.

Pilot projects have shown that, in many cases, improvements can be made with little investment. For example, risks can be reduced by raising awareness of workers, use of appropriate Personal Protective Equipment (PPE) along with training, and reorganising and tidying up a warehouse.

National Cleaner Production Centres (NCPCs) and other Technical Service Providers

NCPCs were jointly established by UNEP and UNIDO (starting in 1994) to deliver Cleaner Production services to businesses, government bodies and other stakeholders and to assist them with the implementation of Cleaner Production methods, practices, policies and technologies, focusing on developing countries and countries in economic transition[11].

Consequently, UNEP's RP approach enables NCPCs to enhance their service portfolio to support companies in managing risks of chemical accidents. The case studies in this publication can provide the NCPCs with a volume of experience that may help them to more effectively coordinate awareness-raising activities, training programmes aimed at target company employees and potential trainers, and plant assessments. This publication also provides practical guidance and experience for NCPCs that offer services related to risk identification and prevention.

Furthermore, the benefits of these case studies apply to other providers of technical services related to Responsible Production (such as technical experts, suppliers of safety equipment, etc.). Since RP requires companies to rethink chemical hazard management and to develop appropriate strategies, they may require support from external service providers. The detailed descriptions in this publication relating to implementing RP on-site may prove useful for technical service providers that are looking to extend their service portfolio, especially in those developing countries where NCPCs are not currently present.

Moreover, the development of risk reduction measures within the framework of RP may also be relevant for companies that provide technical solutions including, for example, manufacturers of safety or personal protection equipment (*e.g.*, fire and rescue gear, products for facility maintenance, safety clothing).

Industry associations

Industry associations, representing the interests of their member companies, are involved in fostering collaboration, the exchange of experience among companies, and the development of industry standards. They are often involved in activities such as

[11] UNIDO. "National Cleaner Production Centres (NCPCs) and Networks." http://www.unido.org. Web. 25 May 2012. http://www.unido.org/index.php?id=o5133.

organising conferences, seminars and training programmes or providing advice on legal, technical and policy matters.

Industry associations and their associated networks can promote the RP approach in different countries, by fostering the dissemination of RP Handbook and Toolkit and promoting its use.

In addition, industry associations have access to sources of information that may be beneficial for the further development and implementation of the RP approach. For example, such associations can support this initiative by providing materials and information on best practices in different industrial sectors.

The publication might be of particular relevance for chemical industry associations (national as well as international) since Responsible Production is aligned to their goals such as those of Responsible Care® and Global Product Strategy (GPS). The case studies presented in this publication allow chemical industry/ manufacturers associations to identify linkages with the work that they are already doing.

National and Local Authorities

National and local authorities in developing countries may find promoting RP a valuable way of achieving a better level of compliance with laws and policies related to environmental and chemical risk management. Authorities have the power to promote the wider dissemination and use of RP among SMEs within their respective jurisdictions.

While Responsible Production is a voluntary approach, it can support the private sector in reaching the targets established by authorities. This publication highlights the potential value-added of voluntary measures in reducing the risks of chemical accidents. It also encourages SMEs to approach authorities, and it stresses the importance of constructive interaction between authorities and companies in addressing process risk reduction.

At the same time, this publication helps raise awareness among local authorities, who may find it a source of inspiration and guidance for designing inspection programmes and protocols.

Insurance companies

Insurance companies have a vital interest in having the risks of their customers systematically identified, evaluated and addressed in an appropriate way. This applies to industrial customers that produce, use or handle hazardous substances in their operations, as well as companies that are part of the value chain.

However, insurance markets in the majority of developing countries are not-well developed with respect to the issue of chemical safety, which could pose a risk to industrial development as companies have fewer possibilities to compensate for possible losses.

Insurance companies have developed numerous tools (*e.g.*, questionnaires, computer programmes, checklists) that help companies identify emerging risks, at the same time allowing insurers to adequately assess potential risks. However, most of these tools have been developed with large companies in mind and do not meet the specific needs of SMEs in developing and transition countries. As many of these enterprises have limited resources (technical, human, financial), addressing even the most crucial risks remains challenging. This is also reflected by the observation that many SMEs in developing and transition economies are heavily underinsured.

If insurance companies couple the provision

of insurance services with a requirement for clients to implement RP services, and provide related support services, it would have the potential to significantly reduce risks - both for the insurer and the insured. Through this publication, insurance companies are provided with concrete case studies to demonstrate the risk reduction potential of the RP approach.

With the systematic methodology for identifying and assessing potential risks and for implementing appropriate risk reduction measures, RP offers the insurance industry a tool for supporting the development of insurance services in new markets.

Potential Donors for Chemical Safety Management Projects

OECD[12] countries, the European Commission and industry associations provide support for initiatives to help developing countries and companies to establish and improve chemical safety management programmes. For any country or organisation that is funding (or considering funding) such initiatives, this publication offers valuable insights on possible activities and their outcomes.

The case studies in this publication can give funders motivation and rationale for supporting this UNEP initiative, as well as insights on how this could fulfil the funders' policy objectives. This publication enables potential donors to see how their contributions could help prevent adverse effects to humans, the environment and property by preventing chemical accidents at SMEs in developing countries.

International organisations

A number of international organisations, including United Nations Environment Programme (UNEP), Food and Agriculture Organisation (FAO), World Health Organisation (WHO), United Nations Industrial Development Organisation (UNIDO), United Nations Institute for Training And Research (UNITAR), the Organisation for Economic Co-operation and Development (OECD) and United Nations Development Programme (UNDP), have committed to the goal set by SAICM[13] to integrate sound management of chemicals into planning processes for developing countries and countries with economies in transition. These organisations have an important convening role in encouraging industry of all sizes to make the efforts necessary to achieve the SAICM "2020 target" (see footnote 13).

The RP approach promotes the SAICM target and can be used by different international organisations as part their activities. Through this publication, international organisations can recognise linkages with related initiatives and help different organisations understand the relationship between different chemical safety management approaches designed for an industrial sector or an individual company. This can facilitate joint projects and other forms of cooperation, as well as more efficient investments, to holistically improve the safe management of chemicals in SMEs that produce, use or handle hazardous chemicals. This could help to streamline the international activities, not only for the organisations but also from the countries' and companies' perspective.

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[12] Organisation for Economic Cooperation and Development

[13] The Strategic Approach to International Chemicals Management (SAICM), adopted at the International Conference on Chemical Management in Dubai (2006), sets the stage for improving sound chemical management at the global level, the aim being that by 2020 chemicals are used and produced in ways that lead to the minimisation of significant adverse effects on human health and the environment.

RESPONSIBLE PRODUCTION IN THE GLOBAL CONTEXT OF CHEMICAL SAFETY MANAGEMENT

2

Responsible Production, designed to reduce risks and prevent chemical accidents at SMEs, is complementary to other initiatives that address the safe or efficient use of chemicals. It builds on experience from various voluntary approaches, notably APELL (Awareness and Preparedness for Emergencies at Local Level), Safer Production, and Corporate Social Responsibility (CSR) *(see Chapter 1)*.

(Source: Predrag1 - Fotolia.com)

RELATED LEGAL SYSTEMS

Voluntary approaches help support the efforts of national authorities by improving companies' compliance with legislative and permit requirements. In some cases, regulations addressing chemical accident prevention apply only to enterprises that produce, use or handle a certain quantity of hazardous chemicals (threshold quantity). Furthermore, in many developing countries there may not be sufficient legal systems for managing chemical hazards or there is limited capability for enforcement of requirements that do exist.

RP can complement the objectives of legally binding instruments, policies and programmes for risk reduction and accident prevention. RP also takes into account elements of legal frameworks, including those that deal with major accident prevention and preparedness, occupational health and safety, and classification and labelling of chemicals (Refer to Annex I). These may provide guidance and leadership for countries that do not have strict chemical management regulations in place. The following gives some examples of related legal systems.

Occupational Health and Safety

Most countries have some regulations in place for managing occupational health and safety (OSH) issues, and so SMEs may be familiar with OSH-related legal requirements and may be accustomed to on-site OSH inspections. Building on OSH helps companies understand and apply RP, which extends some of the OSH concepts to address the safety of the local community as well as those in the value chain.

Globally Harmonised System of Classification and Labelling of Chemicals (GHS)

GHS is a system for defining and classifying the health, physical and environmental hazards of chemicals as well as for communicating hazard information[14]. The GHS aims at ensuring that information on physical hazards and toxicity from chemicals is available in order to enhance the protection of human health and the environment during the handling, transport and use of these chemicals. This system is used by many countries in establishing regulations for chemical accident prevention and preparedness[15].

National application of the GHS approach can improve hazard communication, providing the employees of the SMEs and other companies in the value chain, as well as the public, reliable and practical information on the hazards of chemicals so that they can take effective preventive and protective measures for their health and safety.

Use of the GHS can also help remove barriers to trade, supporting compliance with requirements that relate to the export of products to markets, such as Europe and the US, where regulatory regimes related to the classification and labelling of products tend to be stricter.

Registration, Evaluation, Authorisation and Restriction of Chemical substances

European regulations, such as REACH and CLP[16] can have influence outside of Europe and may have impacts on companies that are the target group of RP. With REACH, product stewardship of chemical manufacturers is enhanced requiring extensive risk assessment and information to be available down the supply chain. Importantly, the CLP regulation streamlines hazard labelling according to GHS. Furthermore, companies (including SMEs) from outside the EU are obliged to comply with REACH/CLP legislation when they intend to offer their products on the European market. In this sense, the relationship between RP and REACH goes two ways: REACH leads to better data being available on chemicals and RP can help manage chemical data for those companies needing to comply with REACH for export purposes.

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[14] United Nations. "Globally Harmonized System of Classification and Labelling of Chemicals (GHS)." United Nations Economic Comission for Europe. 2011. Web. 7 May 2013. http://www.unece.org/trans/danger/publi/ghs/ghs_rev04/04files_e.html

[15] Efforts are underway to incorporate the GHS into international legal instruments addressing chemical accident risks including the Seveso III Directive on the control of major-accident hazards involving dangerous substances (Directive (2012/18/EU).

[16] European Union, the Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH- EC 1907/2006) deals with the control of risks that chemicals pose on human health and the environment. At the beginning of 2009, REACH was complemented by the regulation 1272/2008 on the classification, labelling and packaging of substances and mixtures ("CLP Regulation") which aligns the classification, labelling and packaging of chemical substances with GHS.

RELATED VOLUNTARY APPROACHES

In addition to the growth in the amount of chemicals-related regulation, voluntary approaches to manage chemical hazards have become more popular. A number of intergovernmental organisations and industry associations have initiatives to support improved management of chemical hazards that are relevant for SMEs and their communities. Whereas in general the goals and aims of the voluntary management approaches are similar to some extent, they tend to differ in scope and language. The following gives some examples of related voluntary instruments.

International Council of Chemical Association's (ICCA) Responsible Care® and Global Product Strategy

RP was developed in cooperation with the ICCA and was inspired by, and complements, Responsible Care® and the Global Product Strategy. RP provides a comparable strategy with a focus on smaller companies in developing countries that may not have the support of national chemical industry associations.

Promoted by the ICCA, Responsible Care® is the chemical industry's global initiative that drives continuous improvement in health, safety and environmental (HSE) performance, together with open communication with stakeholders. The Responsible Care® framework reflects the concept of sustainable development and embraces various aspects such as environmental protection, product responsibility, occupational health and safety, plant safety, hazard avoidance and transportation safety[17]. Responsible Care® also requires companies to be open and transparent with their stakeholders: local communities, environmental lobby groups, local authorities, government, media, and the general public.

Responsible Care® is implemented by ICCA through national chemical manufacturing associations and, through them, by individual companies. Activities have so far mainly concentrated on enterprises in industrialised countries. However, currently efforts are being made to build the capacity of ICCA member companies in developing countries and countries with economies in transition.

Global Product Strategy (GPS) is intended to reduce existing differences in the safe handling of chemical substances between developing, emerging and industrialized countries by building capacity for chemicals risk assessment among developing and emerging economies and by increasing transparent access to reliable product safety

[17] International Council of Chemical Associations. "Responsible Care®." Web. 9 April 2013. http://www.icca-chem.org/en/Home/Responsible-care/What-we-do.

information. The aim of the GPS is to enhance product stewardship throughout the value chain. The product stewardship principles of the GPS correspond with the Responsible Production principle of looking at the entire value chain, and being transparent about risks[18].

> ***Promoting sound management of chemicals globally is a key priority for the chemical industry. ICCA's Global Product Strategy and Responsible Production both specifically target SMEs. To promote this shared goal more efficiently is one of the objectives under our UNEP-ICCA Memorandum of Understanding. It gives us great pleasure to see the success story of implementing Responsible Production summarized in this report as it demonstrates the value of joining multi-stakeholder efforts for capacity building.***
>
> Martin Kayser
> **Co-Chair ICCA Chemical Policy & Health Leadership Group**
> **ICCA**

UNEP's Flexible Framework for Addressing Chemical Accident Prevention and Preparedness (CAPP)

UNEP established the Flexible Framework Initiative in 2007 in order to support any national government that wishes to develop, improve or review its programmes or policies related to the prevention of, and preparedness for, chemical accidents. It consists of two primary components: the development of guidance materials including *The Flexible Framework for Addressing Chemical Accident Prevention and Preparedness – A Guidance Document* (2010) and its related Implementation Support Package (2012), and Chemical Accident Prevention and Preparedness (CAPP) Programme Projects, providing support to individual countries in connection with efforts to improve chemical accident prevention and preparedness.

The *Flexible Framework Guidance* describes a process for reviewing and developing a CAPP Programme and contains a description of the key elements of a typical CAPP Programme, based on international legal instruments (*e.g.*, the relevant ILO and UNECE conventions, EU Directives, and US laws). While focusing on the role of national governments, the Flexible Framework Guidance builds on many of the same instruments that contributed to the RP approach and has the same objective of improving chemical safety of

[18] International Council of Chemical Associations. "Global Product Strategy." 9 April 2013. http://www.icca-chem.org/Home/ICCA-initiatives/Global-product-strategy.

industries, particularly in developing countries and countries in economic transition, but approaches the issue from a policy perspective.

OECD Guiding Principles for Chemical Accident Prevention, Preparedness and Response (2nd ed.)

The *Guiding Principles*, published in 2003 (with subsequent addendum), set out general guidance for the safe planning, construction, management, operation and review of safety performance of hazardous installations in order to prevent accidents involving hazardous substances and, recognising that such accidents may nonetheless occur, to mitigate adverse effects through effective land-use planning and emergency preparedness and response. These principles address the roles and responsibilities of public authorities, industry, employees and their representatives, as well as other interested parties such as members of the public potentially affected in the event of an accident, and non-governmental organisations.

These *Guiding Principles* apply to all hazardous installations, *i.e.*, fixed plants/sites that produce, process, use, handle, store or dispose of hazardous substances such that there is a risk of an accident involving the hazardous substance(s) and are based on the premise that all hazardous installations should be expected to comply with the same overall safety objectives irrespective of size, location or whether installation in publicly or privately owned. The *Guiding Principles* provide practical advice and reflect best practices from countries and companies worldwide and, therefore, can provide support to SMEs in developing and implementing their action plans to reduce risks.

Chemical Management Guide for SMEs

This guidance, developed by the German Agency for International Cooperation (GIZ)[19] is specifically targeted at SMEs in developing countries[20]. Similar to the Responsible Production approach, the GIZ guidance is composed of a number of tools, providing a step-by-step approach to identify hazard hotspots and to generate a chemical inventory. It helps with observing risks, calculating potential losses, and supporting measures for improvement. Importantly, this approach focuses on on-site hazard management, in comparison to RP activities, which consider a company's entire value chain.

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[19] The German Federal Government has launched a new agency for technical cooperation (GIZ) early 2011, merging the three government organisations GTZ, GEZ and InWEnt.

[20] Deutsche Gesellschaft Für Technische Zusammenarbeit (GTZ). *Chemical Management Guide for Small and Medium Sized Enterprises*. Rep. 2008. Web. 9 April 2013. http://www.giz.de/Themen/en/dokumente/Guide_E_300708.pdf.

COMPLEMENTARY STRATEGIES AND BUSINESS MODELS

Like the previous sections show, Responsible Production is not an entirely new approach for dealing with chemical hazard management and, as such, it is not meant to be considered in isolation. It is likely that companies that are thinking about applying RP are familiar with measures related to environmental management, resource efficiency or chemical safety management. The following sections describe some of the most pertinent methodologies.

Resource Efficient and Cleaner Production (RECP)

RECP refers to a cooperative effort by UNIDO and UNEP to advance sustainable industrial development, and consumption and production in developing and transition countries. It aims to improve resource efficiency and environmental performance of businesses and other organisations. RECP continuously applies preventive environmental strategies to processes, products and services. This increases efficiency and reduces risks to humans and the environment.

RP supports the application of RECP approaches, through minimisation of toxic chemical releases as well as reduction of the amount of toxic materials on site, spillage, and hazardous wastes, RP can be a key contributor to increased resource efficiency and cleaner production.

Environmental Management

Many companies formalise their environmental management activities in an Environmental Management System (EMS) which consists of a set of processes and practices that enable them to continuously improve environmental performance, and optimise operating efficiency[21].

Chemical Leasing (ChL)

Promoted by UNIDO, ChL aims for increasing the efficient use of chemicals and reducing the risks of chemicals, while helping to protect human health and improve the economic and environmental performance of participating companies. The ChL approach aims to enhance communication between suppliers and users of chemicals and use suppliers´ knowledge to improve efficiency and safety of chemicals use, storage and handling. In a traditional business model, suppliers of chemicals aim to maximise their sales to their

[21] United States Environmental Protection Agency. "Environmental Management Systems (EMS)." http://www.epa.gov. 15 Dec. 2011. Web. 17 May 2012. http://www.epa.gov/ems.

customers, thus rewarding inefficient use of chemicals. With ChL, customers only pay for the services provided by the chemicals (*e.g.*, volume of water treated, number of parts painted, length of pipes cleaned), rather than for the amount of chemicals consumed. By decoupling the payment from the consumption of chemicals, ChL encourages better chemicals management resulting in improved environmental performance as well as economic benefits for both the suppliers and customers.

Lean Manufacturing

Under the so-called "Lean Manufacturing" business model, companies aim to eliminate non-value adding activities, consequently improving efficiency and product quality. These approaches focus on driving quality and delivery, typically leading to environmental and resource efficiency benefits. This is accomplished through a culture of continuous improvement, employee empowerment and waste minimisation and housekeeping. Methods related to Lean Manufacturing practices include, for example 5 S and Six Sigma[22].

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[22] The 5 S management system focuses on the orderly workplace as a way to reduce waste and optimise productivity. Its five pillars are "sort", "set in order", "shine", "standardise", and "sustain". This provides a methodology for organising, cleaning, developing and sustaining a productive work environment. The process helps each and every employee be part of improving working conditions, and reduce waste and in-process inventory.

Six Sigma is a business management strategy that aims to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimising variability in manufacturing and business processes using a set of quality management methods. Each Six Sigma project carried out within an organisation follows a defined sequence of steps and has quantified financial targets (cost reduction and/or profit increase). The approach helps an organisation correctly diagnose the root causes of performance gaps.

Source: United States Environmental Protection Agency. "Lean Thinking and Methods." http://www.epa.gov. 10 Nov. 2011. Web. 7 May 2013. http://www.epa.gov/lean/environment/methods.

GLOBAL RESPONSIBLE PRODUCTION PROMOTION ACTIVITIES

3

Upon publication of the Responsible Production Handbook in 2010, UNEP initiated an effort for its global dissemination, to increase awareness of the target audience about the new tools that are available. The events organised by UNEP served to promote the idea of the RP approach and to identify possibilities for joint implementation with relevant partner organisations. The following sections outline the global networks and audiences that were introduced to Responsible Production during the first two years after the publication of the Handbook.

(Source: Michael Jung - Fotolia.com)

UNEP'S REGIONAL OUTREACH

In 2010, UNEP organised four training sessions to introduce Responsible Production and Resource Efficiency to all directors and interested staff of the UNEP-UNIDO Network of National Cleaner Production Centres (NCPCs). Specifically, training sessions were held for: the Latin American and Caribbean NCPCs (in Panama City, May 2010); the NCPCs of the African and West Asian region (Cairo, June 2010); the NCPCs located in the Asia-Pacific region (Colombo, June 2010); and the Central and Eastern European NCPCs (Vienna, October 2010). As a result, approximately 90 representatives of the NCPCs and other similar technical service providers, selected government agencies and international organisations received a basic introduction to RP.

The training sessions included general presentations on Responsible Production and related the tools as well as interactive exercises using concrete case studies to provide the participants with sufficient information to understand how to efficiently integrate Responsible Production into their existing service portfolios.

Following these introductory training sessions, UNEP translated the Responsible Production Guidance and Toolkit into Arabic, Chinese, French, Spanish, Thai and Vietnamese and supported several NCPC to launch pilot applications of RP in their respective countries. The results of the country initiatives are documented in Chapter 4.

BUILDING SYNERGIES WITH RELATED NETWORKS AND INITIATIVES

UNEP continues to build partnerships with organisations that are engaged in activities related to the sound management of chemicals, in order to promote RP in synergy with other initiatives. Table 1 summarises the relevant activities that UNEP has undertaken in partnership with other organisations including the outcomes of the corresponding events.

Table 1: Building Partnerships in Chemical Safety Management

AFRICA & WEST ASIA	NAIROBI KENYA OCTOBER 2011	**UNEP-ICCA African Regional Workshop on Chemical Safety Management**	This workshop focused on two Chemical Safety Management Approaches: Responsible Production and ICCA's Global Product Strategy. Approximately 50 NCPCs and SAICM focal points from the African Region, as well as a number of international representatives of chemical industry and industry associations, attended the workshop with funding made available by the ICCA. Through the workshop, UNEP and ICCA were able to understand the pressing issues and priorities for the African Region in order to build an appropriate joint capacity building programme for the region.
	CAIRO EGYPT JUNE 2012	**Closing Event of SAICM QSP project "Assessment and Capacity Building in Chemicals and Chemical Waste Management in Egypt"**	In the closing workshop of the SAICM Quick Start Programme funded project, implemented by UNIDO and Egypt National Cleaner Production Centre, UNEP presented the Responsible Production Approach and UNEP's partnership with the chemicals industry. The audience consisted mainly of private sector representatives (approximately 120 participants from 40 companies). Two company representatives presented the results of RP implementation in their respective companies. Some of the results mentioned included better labelling, introducing spill kits and better PPE use, floor isolation, automatic sprinkler/ fire systems recycling of all solvent waste in production, and establishing a cross-cutting team for safety.
ASIA	HANOI VIETNAM OCTOBER 2010	**PREMAnet General Assembly**	Following an invitation from a GIZ Convention Project on Chemical Safety addressed to UNEP, the Vietnam National Cleaner Production Center (VNCPC) presented the new Vietnamese version of UNEP's Responsible Production Handbook at a training event during the PREMAnet General Assembly which targeted PREMAnet experts in the region in supporting and guiding companies in reducing the costs and risks related to storing, handling, using, and disposing of chemicals.

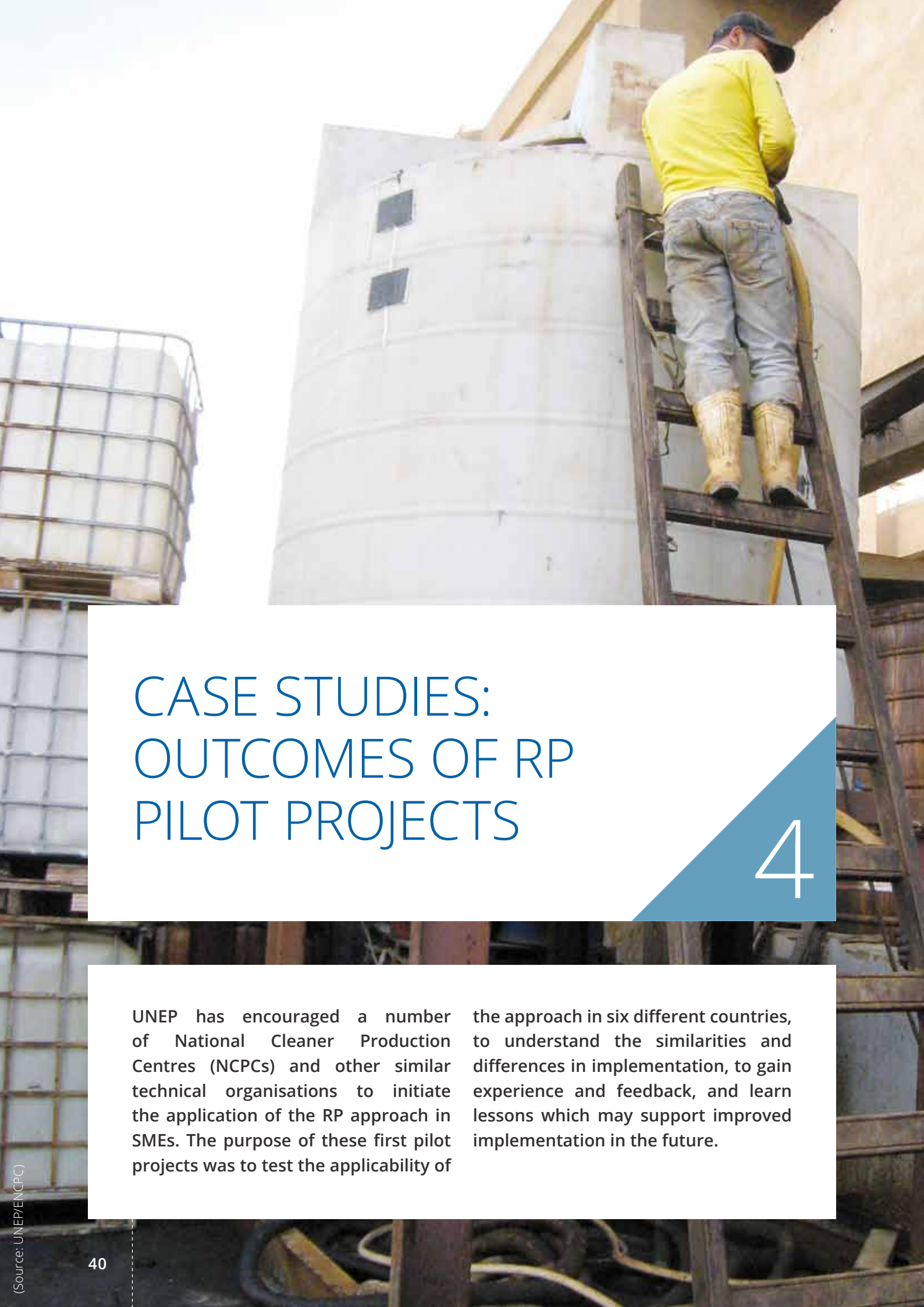
ASIA	**MANILA PHILIPPINES MAY 2011**	**Training Workshop on RP and APELL**	This UNEP-organised intensive training course was attended by approximately 70 participants representing the Filipino Chemical Industry Association (SPIK), several chemical companies, government agencies and civil society. RP was presented in the wider scope of Sound Chemicals Management, which the participants appreciated. As a consequence of the workshop, some companies asked for potential support from UNEP and expressed their willingness to start a Responsible Production based initiative. They also suggested that UNEP prepare a package with further advice on choosing the right tools for a specific company situation.
	COLOMBO SRI LANKA OCTOBER 2011	**Meeting of the National Working Group for Chemical Leasing**	The working group for Chemical Leasing in Sri Lanka, which consists of members representing industry, academia, government and national consultants, intends to disseminate and promote approaches for a more efficient use of chemicals (*e.g.*, via process optimisation as a result of closer collaboration of actors in the supply chain). Synergies between ChL and RP were explained during this regular meeting of the working group (attended by approximately 20 participants). The group decided that, in Sri Lanka, future Chemical Leasing Projects should always examine the feasibility of including RP.
	BEIJING CHINA NOV 2011	**Global APELL Anniversary Forum**	UNEP's *Global APELL Anniversary Forum: 25 years of Local Level Preparedness and Environmental Emergency Management* attracted over 170 participants including representatives from 17 countries' government agencies, international companies, international and regional organisations, academia, and civil society, as well as Chinese participants from 28 environmental emergency management bureaus of provinces, autonomous regions and municipalities, 13 large-scale chemical companies and mining groups, and related research institutes/universities. One session was explicitly dedicated to RP. Case studies from China and Sri Lanka highlighted achievements. Notably, several Chinese companies and associations showed strong interest in further disseminating the concept in China.
	HANOI VIETNAM DEC 2011	**UNIDO Responsible Production and Chemical Management Plan- Project Workshop**	A workshop related to a UNIDO project entitled "Responsible Production and Chemical Management Plan", introduced Responsible Production in connection with Corporate Social Responsibility to more than 100 Vietnamese stakeholders, mostly from the textile, footwear and electronic industries. Six workshops were held in, and near, Saigon and Hanoi. The way in which RP can help a company comply with European legislation and international agreements was emphasised, as this is important for export-oriented industries. The audience confirmed that RP is a simple and effective tool which can support the companies in order to improve their performance *e.g.*, in safety and health, CSR and legal compliance.
	BANGKOK THAILAND MARCH 2012	**Expert Workshop on APELL and RP in Thailand**	A regional expert workshop was organised in Bangkok, Thailand on 29 February- 2 March 2012. The workshop was co-hosted by the Department of Industrial Works (Thailand), the Asian Disaster Preparedness Center (ADPC) and UNEP. There were approximately 50 participants from the public and private sector (chemical companies) along with experts from different countries in the region, including China, India, Sri Lanka, Thailand, and Vietnam. Participants indicated an interest to develop regional and local expert pools in the field of chemical safety.

EUROPE	MUNICH GERMANY SEPT 2010	Asia-Europe Environment Forum 2010	RP was presented in a breakout session focusing on Chemical Leasing. The general principles and potential synergies of the two approaches were presented to the audience consisting of approximately 20 participants from European and Asian countries representing governments, companies, associations and donors. These participants were informed about the launch of the Responsible Production Handbook.
	ST. PETERS-BURG RUSSIA MAY 2011	UNIDO Meeting of the International Working Group on Chemical Leasing	RP was introduced to 30 representatives of governments, companies and Chemical Leasing experts of NCPCs. The workshop's discussions indicated that, through applying the Chemical Leasing business model, producers have an economic interest to support their customers (users) with the implementation of RP in order to prevent chemical accidents. At the same time, engaging suppliers of chemicals in stakeholder consultations during the course of RP activities may provide additional ways to further disseminate the idea of Chemical Leasing.
	BELGRADE SERBIA NOV 2011	UNEP-ICCA Side Event of 1st Meeting of SAICM OEWG	In this UNEP-ICCA side-event, which was held during the course of the first meeting of the SAICM Open Ended Working Group (OEWG), UNEP and ICCA promoted the importance of sharing of tools with common goals (RP and tools of the Global Product Strategy) to achieve the goals set by SAICM. The participants (approximately 30) mainly representing various government agencies attending the OEWG, endorsed UNEP's partnership with the chemicals industry and generally perceived combining the UNEP approach with the industry approach for the purpose of a RP pilot project with interest.
LATIN AMERICA	BOGOTA COLOMBIA MARCH 2011	Workshop related to GIZ Approaches on Risk Reduction & Accident Prevention	A workshop supported by ARP Sura, a Colombian insurance company, focused on the GIZ Risk Management approach. More than 100 participants attended the workshop. The event was seen as a chance to convince an insurance company to support their SME clients on systematic risk reduction and accident prevention using GIZ and UNEP tools. During the workshop, it became clear that big companies with significant chemical risks (*e.g.*, refineries, big chemical production sites) have their own well-elaborated risk reduction and control tools, often developed together with insurance companies. The participating companies clearly stated that the typical tools of large industrial companies do not fit the context of SMEs, creating a niche for RP in this field.
	RIO DE JANEIRO BRAZIL SEPT 2011	UNIDO International Chemical Leasing Workshop	This UNIDO workshop was designed as a launching event for Chemical Leasing in Brazil. Its focus was to show how chemicals can be used more efficiently by an intensified collaboration between supplier and user. Participants (approximately 120) included representatives of the Federal Environmental Ministry, local authorities, companies, and academia as well as consultants. A presentation on RP was included, informing the audience not only on the general principles and advantages of RP, but also providing information on the on-going activities in Brazil which are based on a Memorandum of Understanding between UNEP and ABIQUIM.

PICTURE 1

Global Responsible Production Promotion Activities

(Source: Sri Lanka NCPC, China NCPC)



CASE STUDIES: OUTCOMES OF RP PILOT PROJECTS

4

UNEP has encouraged a number of National Cleaner Production Centres (NCPCs) and other similar technical organisations to initiate the application of the RP approach in SMEs. The purpose of these first pilot projects was to test the applicability of the approach in six different countries, to understand the similarities and differences in implementation, to gain experience and feedback, and learn lessons which may support improved implementation in the future.

(Source: UNEP/ENCPC)

These first industrial Responsible Production pilot projects were implemented in: China, Egypt, El Salvador, and Sri Lanka in partnership with NCPCs; in Thailand in partnership with the Thailand Environmental Institute (TEI); and in India in partnership with the Asia Society for Social Improvement and Sustainable Transformation (ASSIST).

The case studies are presented in the following sections (in no specific order). The list below summarises the companies where Responsible Production was implemented. This Chapter tells the story of these pilot projects and presents case-specific feedback and lessons learned.

Summary of RP pilot companies

Thailand

- Bara Chemicals: Melamin resins and acryl emulsions
- TJC: Agro-chemicals
- Kemfac: Agro-chemicals
- Q-Fac: Agro-chemicals
- Bangkok Chemicals: Sulphuric acid

Egypt

- Chimi Art: Ferric chloride, corrosion inhibitors, caustic soda, sulphuric acid, additives
- Eagle Chemicals: Resin and Polymer Products (Water based polymers, solvent based resins)
- GMC: Household Equipment

Sri Lanka

- Silicone Coatings: Paints
- Samson Compounds: Rubber Footwear

China

- Zhong Ke San Huan: High technology (Nd Fe-B magnets)
- Hebei Veyong Bio-Chemical: Bio-vetenirary drugs

El Salvador

- Lacteos La Isla: Dairy Products
- Martinez & Saprissa: Textile

India (Gujarat)

- Industrial Chemical Works: Sulphonic acid, dyes, pigments
- J.B. Industries: Dye intermediates
- Shree Organo Chemicals: Dye intermediates

THAILAND

Thailand was the first country which experimented with RP implementation. This first pilot project was launched in 2007 (before the regional training workshops) and served to test the applicability of the draft Responsible Production Toolkit that was being developed at the time by UNEP and AccountAbility.

Through the project *"Engaging Business and Supply-chain in Safer Production and Emergency Preparedness through Applied Corporate Social Responsibility at Site Level"*, the Thai pilot project aimed to foster safe work practices and sharing of chemical safety information along the value chain, to involve national and local level authorities from industrial areas in broad-based safety management, and to develop guidelines and a training package. This case study summarises the activities and achievements that were undertaken as part of the project and then provides an overview of the experience of five pilot companies.

Activities and Achievements

UNEP launched the Responsible Production project in Thailand in partnership with local organisations including the Department of Industrial Works (DIW), the Thailand Environment Institute (TEI), the Industrial Estate Authority of Thailand (IEAT), Mahidol University (MU), Responsible Care® Management Committee of Thailand, Chemical Industry Club of the Federation of Thai Industries (FTI) and the company Clariant Chemicals, as well as the German Agency for International Cooperation (GIZ[23]). This project built on previous work undertaken by GIZ from 2004 to 2006 concerning Risk Management Planning.

FIGURE 2

Map identifying Bangpoo Industrial Estate, Thailand

(Source: Google Maps)

The project addressed four groups of stakeholders:

- selected chemical plants;
- inspectors (safety inspectors and industrial estate authority inspectors);
- industrial chemical safety experts and local government officers; and
- community committees.

Because the participating companies had some knowledge of risk management and emergency preparedness, it was possible to perform an exercise that involved stakeholders and that addressed improved

[23] Former GTZ: Deutsche Gesellschaft für internationale Zusammenarbeit

communication with the community and community hotspots mapping. As a result, the companies' employees learned about risks related to chemicals use in their communities. In addition, the companies developed emergency plans, which were integrated in the provincial emergency plan.

The project led to the establishment of an information network for chemical emergency preparedness and response as well as to the establishment of chemical accidents and emergency preparedness action plans in the Bangpoo Industrial Estate. The IEAT also acquired an approach for improving risk communication to be replicated in other Industrial Estates. Text Box 1 summarises the activities of the project.

TEXT BOX 1

OVERVIEW OF RP IMPLEMENTATION ACTIVITIES IN THAILAND

1: Selection of companies
2: Analysis of current practices and potential hazards
3: Training of safety inspectors and work safety officers
4: Assessment chemical safety issues in pilot companies
5: Improvement of practices on chemical safety issues
6: Engaging the community in chemical risk mapping

Activity 1 - Selection of companies

The first activity consisted of choosing a pilot site for the project demonstration, which was the Bangpoo Industrial Estate (BPIE) area. The pilot companies were selected from this area and its close vicinity, as well as from outside of this area. The BPIE, located in the Samutprakarn Province in Thailand, is an industrialised zone dating back to 1977 housing 88 chemical companies which are mainly SMEs (90 %). Because of the high number of chemical SMEs located inside and in the vicinity of the industrial area, and the significant quantities of chemicals stored and handled there (more than 100,000 tons/year), the BPIE was considered a suitable site for this pilot demonstration project. This choice was further justified by the number of accidents that have occurred at BPIE in recent years: between 1995 and 2007, 47 accidents occurred in the BPIE including 31 fires, five explosions, two explosions followed by fires, and nine chemicals releases. For example, a fire with devastating impacts occurred in early 2007, when a fire engine could not reach the site as the way was blocked by waste materials.

Five pilot companies were involved in implementing the measures, *i.e.*, Bara Chemical Co., TJC, Kemfac, Q-FAC and Bangkok Chemicals, all located in BPIE.

Activity 2 - Analysis of current practices and potential hazards

The participating Thai industry had some experience with risk management and emergency preparedness, and most of the pilot companies had already implemented some risk reduction measures. Marking (banding and zoning) of different chemicals storage areas was already a common practice

of the plants in BPIE area. Nevertheless, the level of safety management was observed to differ among the companies at the start of the project. Furthermore, none of the companies had an active emergency preparedness plan.

Using a DIW guideline on risk assessment and training support provided by BPIE, the enterprises in the estate improved their capacity to implement risk assessment, risk control and risk reduction measures. The companies made progress in particular with respect to identifying risks and documenting these. All unacceptable risks were reviewed and proper risk reduction measures identified.

Activity 3 - Training for safety inspectors and work safety officers

To start with, staff of fourteen chemical companies as well as emergency responders, community representatives and safety inspectors from DIW received training on RP concepts, methodologies and tools. A training package was prepared to cover all the issues essential for understanding the RP approach.

The training focused on good practice related to a range of chemical management and safety issues, risk assessment, understanding of safe process management, risk management planning for emergency preparedness and response, and CSR. The three-day course also addressed issues related to chemical hazards at work, chemicals flow and inventorying, cost-benefit analyses, hazard mapping, and the APELL Programme as well as issues related to stakeholder identification, risk communication, and transport of hazardous substances. All of these are included in a training package that forms a part of the Responsible Production Handbook.

Activity 4 - Assessing chemical safety issues in pilot companies

The TEI prepared further tools to help the pilot companies assess gaps related to RP issues based on approaches that the companies already knew, *e.g.*, Cleaner Technology Audit. The checklist prepared by TEI was in line with the Cleaner Technology (CT)[24] Audit that had already been applied for quite some time in the Thai industry.

The RP team (experts from UNEP and TEI) performed on-site visits to the five pilot companies to review the status of chemical management activities using the checklists developed for that purpose. This task included the assessment of the stakeholder involvement, risk management, and the applicability of the RP approach.

Activity 5 - Improving practices on chemical safety issues

A plan for improving practices related to chemical safety management was prepared based on the recommendations of the RP team. The pilot companies then implemented improvements and monitored them, which was followed by a project evaluation.

It was recognised that there is a need to maintain measures on a continuing basis. Another outcome was the understanding that market pressures, which cause frequent production changes, complicate risk management and can increase risks.

The experiences of the pilot companies in improving practice on safety measures are further elaborated in the chapters below.

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[23] Cleaner Technology Audits are based on the Cleaner Production approach and focus on machines and technologies.

FIGURE 3

Risk Map of BPIE

Activity 6 - Engaging the community in chemical risk mapping

The RP team developed a hazard hotspot mapping of the communities close to the BPIE. This involved mapping of two different scenarios of hazard hotspots off-site involving chemical releases from:

1) stationary sources (such as leakage from a factory storage facility) and
2) mobile sources (*i.e.*, transport accident with hazardous chemicals).

The potential chemical releases were plotted on the BPIE area map with information on the location of vulnerable sites/groups in the community such as schools, hospitals, convenience stores, etc. The mapping was followed by observation of areas and brainstorming on risk scenarios. As a result, a common understanding was developed among the stakeholders on the risk scenarios and appropriate risk reduction measures. With this methodology, all stakeholders became more aware of the potential risks in their community.

Overall, the project showed that stakeholder engagement, in line with the principles of Corporate Social Responsibility, was valued by the top management of the involved Thai industry. To apply CSR to chemical hazard management in practice, the project pointed to the importance of sharing technical knowledge on chemical hazards and effectively communicating this between industry and the local community. It was recognised that involving local authorities and members of the public who generally do not have an understanding or awareness of issues related to chemical risks complicates communication. Nevertheless, this understanding is necessary for authorities to accurately address accident risks.

Overall, RP was recognised to be a flexible modular tool, providing concepts and methodologies that support the range of risk management efforts, addressing diverse issues such as safe production, off-site consequence analysis, emergency preparedness and response planning, and stakeholder engagement. The sections below elaborate on the company-specific experiences in Thailand.

Company Case Study: Bara Chemical Co. Ltd.

Bara Chemical Co. Ltd. is a manufacturer of melamine resins and acryl emulsions. It was one of the first companies established in the Bangpoo Industrial Estate (1973). As a fine chemical producer with an in-house resin formulation, Bara runs several kinds of reactors. Around 130 people are involved in the production, warehousing and transportation of the chemicals and around 20 - 25 people have responsibilities related to handling safety issues.

RP pilot project: Situation before versus situation after implementation

Prior to the implementation of Responsible Production, there was no systematic chemical management structure or practice in place at Bara. A recent expansion of the product portfolio, following increased market demand, resulted in over-crowded space especially in the storage areas, which had an impact on safety. In addition, the company's emergency plan had not considered serious accidents from off-site chemical releases or explosions.

With the initial review, Bara fully identified and understood its key hazards and incorporated the chemical management issues into its new EHS management system, which was being developed at the same time as the RP exercise. Furthermore, Bara created a comprehensive process for listing chemicals along with their quantities and properties, preparing Materials Safety Data Sheets (MSDS) for all materials and products, and maintaining an updated legal register.

The main focus of the RP activities was a review of the risk assessment and the off-site consequence analysis of the hazardous chemicals of concern. During the RP implementation, Bara recognised that insufficient chemical risk communication with the neighbouring facilities was a critical issue to be addressed. As a consequence, Bara decided that a long-term goal should be to intensify chemical risk communication with these companies in order to establish an appropriate coordinated emergency response plan. Notably, in the course of the pilot study, a plan was developed to further improve stakeholder engagement. The results of BARA's RP assessment are summarised in Table 2.

Table 2: RP-related assessment at BARA Chemical Co.

RP Assessment	Green (Excellent) (%)	Yellow (Good) (%)	Red (Poor) (%)	Gray (Not Clear) (%)	Ranking
Input and use of chemicals	50	25	25	-	9
Chemicals Storage and handling	-	-	100	-	2
Chemical risk assessment	-	-	100	-	6
Inventory of Risk	-	-	100	-	7
Stakeholder analysis	-	-	-	100	5
Risk Control Plan	-	-	100	-	8
Emergency preparedness & Response Plan	-	-	100	-	3
Chemical Management Assessment	-	-	-	100	1
Communication and Safety Report	-	-	-	100	4

During the site visits, seven hotspots with associated potential accident scenarios were identified. These are summarised in Table 3.

Table 3: Identified Hotspots and Accident Scenarios at Bara Chemical Co.

Hotspot	Accident scenario
Melamine process	Fire and/or explosion
Acryl emulsion process	Run-away reaction with containment destruction
Acryl emulsion process	Backfiring from the boiler
Production of plastic additives	Powder/dust explosion
Operating control room	The operating control room is located inside of the secondary containment and might be flooded in case of leakage or heavy rain fall
Storage area	Insufficient secondary containment
Outside storage area	Limited access to fire extinguishers
Outside storage area	An overfill protection and a secondary containment for the xylene tank is missing
Warehouse above ground	Drums are not braced together, and may fall from the pallet when being handled
Warehouse above ground	Different substances and materials are stored together

During the industrial site visit, Bara recognised the importance of housekeeping, as well as putting in place secondary containment, to reduce both dust exposure and the risk of dust explosion. To appropriately address accident scenarios, Bara elaborated several risk reduction measures (see Table 4). In addition, the company's Safety officers attended a workshop at Siam PVS (neighbouring company using chlorine) concerning the preparedness in case of a chlorine spill.

Table 4: Identified Risk Reduction Measures at Bara Chemical Co.

Identified Risk Reduction Measures
Make MSDS available for all raw materials and products
Train and assess risks for process change procedures
Purge container with N2 before refilling to avoid ignitable atmosphere
Provide quarterly training of two teams, of twelve workers each, for internal fire emergencies
Apply HAZOP for some processes and chemicals
Establish a training programme on chemical properties and hazards related to the substances being handled at site
Develop an integrated emergency plan that covers scenarios as accidents caused by nearby factories
Avoid dust atmospheres as a source of dust explosions
Provide training to the emergency teams regarding emergencies with low oxygen
Consider appropriate PPE (dust mask instead of respirators, missing helmets or gloves)
Improve secondary containment
Reinstall fire extinguisher for better accessibility
Include transport operations in Emergency Plan
Implement GHS

Obstacles at Bara Chemical Co.

Although Bara performed a systematic risk analysis, the project team noted that the analyses of risk scenarios caused by an intrinsic chemical reaction would need more complex tools like HAZOP and consequently the appropriate technical capacities. Also, it was recognised that frequent production changes that result from market pressure complicate chemical risk management and increase risk.

Lessons learned from the pilot project at Bara Chemical Co.

- One of the most important factors for safe operation is to develop expertise on process safety management to prevent, control, and reduce chemical accident risks with potential for on-site and/or off-site consequences. To ensure safe handling of chemicals, it is essential to train employees on chemical risk management as part of capacity- building activities.
- Bara's diligent housekeeping significantly contributed to the efficient implementation of Responsible Production. Without good housekeeping, additional hazards can be created and existing ones become more difficult to manage.
- Essential to Bara's success with safety was their understanding of risk identification processes.

PICTURE 2

Situation at BARA Chemical Co. before RP Implementation

(Source: UNEP)

- As an important step, the project resulted in a plan to increase cooperation between stakeholders in order to improve chemicals safety management.
- Because market pressures have the potential to cause frequent changes in production, resulting in increased risks, there is a need to implement procedures for managing changing situations.

The pilot project showed that the RP Handbook is applicable to support the activities related to EHS that had already been implemented by the company. The RP tools proved valuable to support EHS operations and the company's risk management framework.

PICTURE 3

Situation at TJC before RP implementation

(Source: UNEP)

Company Case Study: TJC

TJC is a producer of preparations used by the agricultural industry. With around 70 employees (including 12 work safety officers), over 36,000 tons are produced each year.

RP pilot project: Situation before versus situation after implementation

Prior to the pilot project on Responsible Production, TJC had been implementing Cleaner Technology (CT) for more than ten years and TJC found it important to further identify risk scenarios that result in unintentional emissions and accidents.

Although the significance of addressing potential hazards was generally well-understood, on-site visits revealed that some chemical safety aspects had nevertheless not been fully considered. These included, for instance, adequate protective equipment signage and use of appropriate PPE. The major sources of risk were identified: the discharge of contaminated water due to large spillage or fire; handling and use of organophosphate; and the on-site tank storage of xylene.

During the project, TJC gained experience in preparing a fire emergency response plan and gathered information regarding the best possible way to address potential chemical accident scenarios. As a result of the site visit, the APELL process was recommended as a way to improve coordinated emergency preparedness.

Several risk reduction measures were recommended, including improvement of the warehouse management system, labelling of hazardous substances, and the use of adequate PPE.

Risk reduction measures were elaborated for each hazard hotspot (see Table 5).

Table 5: Identified Risk Reduction Measures at TJC

Identified Risk Reduction Measures
Install 300 smoke and heat detectors
Invite retailers for training workshop
Include risk information to products, as required in the Hazard Substances Act
Label drums at storage area
Separate storage of different substances (*e.g.*, flammable liquids, flammable packaging)
Assure better access to pallets
Install safe emergency exit
Implement a colour code for different pallet functions
Install water barriers to avoid emissions of contaminated water
Install an account for chemical lists and GHS
Improve side accessibility of pallets
Provide appropriate PPE
Install secondary containment for fire-fighting water, larger spills and contaminated storm water

The Thailand Environmental Institute (TEI) also helped TJC understand that engaging with the stakeholders in the value chain can help them to improve safety.

Obstacles at TJC

At TJC, the main obstacles for the effective implementation of Responsible Production related to missing expertise: not having enough production supervisors that possess a strong background in chemical safety hindered identifying and implementing appropriate risk reduction measures without external support.

Lessons learned from the pilot project at TJC

In general, the RP tools were easily adopted by the TJC employees who were already familiar with the Cleaner Technology approach. From a methodological perspective, performing a "what-if" analysis was an effective approach for performing a risk assessment, particularly when implemented with skilled workers. Although a bottom-up risk assessment process is time-consuming and requires significant planning, involving shop floor workers in the process was shown to bring more effective results.

The pilot project improved TJC's capacity to prepare a fire emergency response plan and to understand how APELL can be applied as a way to improve coordinated emergency preparedness.

Company Case Study: Kemfac

Kemfac is a manufacturer of agro-chemicals. The company imports and formulates a wide range of agro-chemicals, including herbicides, insecticides and fungicides. In total, 90 % of the raw materials used by the company are transported by a local service.

RP pilot project: Situation before versus situation after implementation

Before the start of the Responsible Production project, Kemfac had already been implementing EHS measures in its operations and therefore the RP project focused on the analysis of risk assessment with different methodologies (such as Fault Tree[25], FMEA[26] and "What if"[27]). Besides some more costly measures, such as the installation of secondary containment, little investment was needed for many of the improvement measures identified ("low hanging fruits"). Such measures included, for example, awareness raising and training of employees, ensuring the consistent availability of MSDSs, and proper labelling of chemical containers as well as putting in place the appropriate signs for PPE. The risk reduction measures are shown in Table 6.

Table 6: Identified Risk Reduction Measures at Kemfac

Identified Risk Reduction Measures
Require to labelling drums with hazard labels
Educate workers regarding properties of zinc phosphide
Raise awareness of workers on MSDS requirements and hazard labels
Apply "four-eyes" principle at unloading operation where the four eyes include tanker driver and trained Kemfac employee
Develop a waste management plan
Ensure that MSDS documents are available in Thai language for all chemicals
Install secondary containment for the xylene pumping area
Install proper heat and smoke detectors
Install fire extinguisher and ventilation systems
Update PPE signs
Use appropriate risk assessment method for identifying risks
Evaluate the possibility of installing overflow prevention valves
Raise awareness and train workers on the correct use of PPE
Require the use of appropriate PPE at all times by all employees
Prepare a classification and inventory of hazardous chemicals
Elaborate a hazard mapping
Improve warehouse organisation and fire protection

Obstacles at Kemfac

Similar to the situation at TJC, the missing expertise for chemical safety among production supervisors was seen as an obstacle that can, without external support, hinder effective implementation of measures.

Lessons learned from the pilot project at Kemfac

Because Kemfac had already been implementing EHS measures, the RP tools were seen as a useful complement to these activities. Implementation of RP significantly improved workers' awareness and understanding of possible consequences of accidental exposure to chemicals. Risk reduction measures such as proper labelling, availability and awareness related to MSDSs, and the provision of training, were shown to contribute to the establishment of an effective chemicals management system.

Company Case Study: Q-FAC

Q-FAC blends, repacks, and stores agrochemicals. The company has two sites: one is used for production and raw material storage; the other is occupied by finished products. The main products processed in the company's facilities are herbicides, insecticides, fungicides and hormones.

RP pilot project: Situation before versus situation after implementation

At the start of the RP project, Q-FAC had insufficient hazard labelling and availability of MSDSs. Many of the chemicals received from suppliers were not adequately labelled. Furthermore, Q-FAC did not have a clear hazard mapping process in place.

As part of the RP pilot project, Q-FAC carried out a risk assessment using the "What-if" method to identify potential hazard hotspots. The approach made it possible to identify 24 risk reduction measures which are listed in Table 7. Although some of the risk reduction measures require installation of equipment, including firewalls and heat detectors, many could be addressed quickly without any appreciable expense. These included, for example, separating pressure bottles with different contents or ensuring free access to fire exits.

Implementation of RP ensured that Q-FAC understood the importance of having MSDSs available for all products, including mixtures, and that these are available in Thai (not only in English or Chinese). The project further helped Q-FAC understand that better labelling of chemicals improves identification of hazards and leads to improved chemicals

[25] The Fault Tree method is a tool that reduces a complex system to single components, assesses probabilities of failures in the single components and correspondingly calculates the overall risk.

[26] The FMEA model consists of 5 steps where certain elements (differentiation into process steps, assessment of impact and probability of accidents, suggestion of risk reduction measures) are similar to RP. Important differences are the development of a functional structure between the different elements and key figures on the probability to identify risks that enter the overall risk assessment.

[27] The "What If?" analysis is a scenario based approach to hazard identification and consequence assessment. For more information, refer to the Responsible Production Toolkit, p.84.

management, as well as helps to segregate hazardous materials in order to keep incompatible materials apart. In this context, enhanced cooperation with suppliers proved to be important. Overall, the RP approach provided Q-FAC with the means to develop a systematic way of identifying and reducing risks. The identified risk reduction measures are shown in Table 7.

Table 7: Identified Risk Reduction Measures at Q-FAC

Identified Risk Reduction Measures
Organise a risk assessment every 5 years (required by authorities)
Provide MSDS for all mixtures and finished products
Prevent workers being in contact with products in case of spillage at the filling station
Install secondary containment; especially at the outside mixing station
Ensure use of appropriate PPE
Provide MSDS for finished products
Rearrange flammable substances storage area
Install fire walls and heat detectors
Assure better access to pallets
Separate pressure bottles (flammable gases, nitrogen, oxygen and hydrogen)
Reduce exposure of workers to corrosive liquids at the filling table
Reduce dust at fungicide filling process
Install secondary containment at outside storage of xylene tank and mixing station
Harmonise PPE requirements and use
Implement Classification and Inventory of hazardous chemicals
Implement a Hazard Mapping tool
Obtain MSDS from appropriate sources
Adapt MSDS and hazard labelling
Implement one consistent standard for warehouse organisation
Keep fire exits free and unlocked
Install a protection cap on unused gas cylinders
Prohibit deliveries of gas cylinders without protection cap
Separate flammable materials and xylene tank

PICTURE 4

Situation at Q-FAC before RP implementation

(Source: UNEP)

Obstacles at Q-FAC

As with several of the other pilot enterprises in Thailand, the lack of production supervisors that have strong background in the field of chemical safety was seen as an obstacle for effective implementation of the RP Approach.

Lessons learned from the pilot project at Q-FAC

This experience showed that RP tools can effectively support the EHS management system at Q-FAC, in particular with regards to reducing risks of injuries related to chemical accidents and the prevention of chronic exposure of workers to chemicals. The RP approach improved workers' awareness and understanding of the possible consequences of potential accidental exposures to chemicals as well as proper labelling practices, and awareness regarding the use of MSDSs.

Company Case Study: Bangkok Chemicals

Bangkok Chemicals is a manufacturer of sulphuric acid. Its production site is about 40 years old. During the company's history, no large leakages, fires or complaints from neighbours have been documented, although small chemical burns from handling sulphuric acid have been acknowledged. There are ten families living at the premises. A future relocation of these families is planned.

RP pilot project: Situation before versus situation after implementation

Bangkok Chemicals was already familiar with assessing safety risks related to its operations. They had experience with using HAZOP, but recognised that the current use of the tool could be improved. By going through a systematic risk assessment with the support of the RP tools, over twenty risk reduction measures were identified. However, Bangkok Chemicals found some of the recommended

risk reduction measures challenging to implement: some of the measures only indicated shortcomings (such as insufficient housekeeping) without providing information on how to overcome them. Nevertheless, these risk reduction measures improved the safety situation regarding, for example, warehousing, use of PPE, labelling, and the understanding of chemical hazards and their risks. The risk reduction measures are summarised in Table 8.

Table 8: Identified Risk Reduction Measures at Bangkok Chemicals

Identified Risk Reduction Measures
Ensure appropriate use of HAZOP method
Strengthen understanding of chemical hazards and their risks
Improve the use of the HAZOP study, especially its criteria for risks assessment
Improve the use of PPE
Improve housekeeping, waste and waste water management
Raise awareness regarding general safety issues
Improve waste water treatment plant
Separate process and rain water
Install a pool to capture contaminated rain water or firefighting water
Store sulphur inside the warehouse
Prevent atmosphere releases of SO2 at the sulphur storage area after scrubbing
Change corroded gas cylinder
Label cylinders
Attach protective caps on unused gas cylinders
Limit access to stored gas cylinders (to reduce amount of stolen protection caps)
Require supplier to deliver gas cylinders that are equipped with protection caps
Prepare and implement of a waste management plan
Prepare and implement a corrosion management plan
Ensure availability and use of appropriate PPE
Install safety showers and eye washers

Obstacles at Bangkok Chemicals

There was an insufficient commitment of the company management and the owner for implementing the Responsible Production approach. A more committed management would have helped to create a culture of safety and to motivate employees to take part in safety improvements. Further obstacles included a lack of incentives for improving working conditions and an insufficient know-how for dealing with chemical hazards. This was seen to be difficult to improve, because the small size of the workforce limited the transfer of knowledge within the teams.

Lessons learned from the pilot project at Bangkok Chemicals

At the end of the pilot exercise, Bangkok Chemicals concluded that more stringent compliance enforcement is an essential driver for safety issues in a small chemical company with very limited capacity. The RP Toolkit might be fully used in this kind of a company. However, it was strongly recommended that the project leader be an external advisor. This helps to identify the most appropriate measures and provide motivation for better commitment.

TEXT BOX 2

THAILAND
SUMMARY OF LESSONS LEARNED

Several lessons emerged from the Thai pilot project, including:

- **The pilot companies found it challenging to disseminate good practices throughout their organisations because of limited awareness of chemical safety aspects. At least two factors help to overcome this: high-level commitment; and creating a safety culture on a continual improvement basis.**
- **Limited awareness and clear understanding of chemical risks by local authorities and communities hinder effectively engaging with these external stakeholders.**
- **Market pressures causing rapid changes in production lead to increased risks. There is a need for appropriate change management procedures that address chemical safety in a changing context.**

EGYPT

Activities and Achievements

In Egypt, UNEP's Responsible Production initiative was included in the Egyptian National Cleaner Production Centre's (ENCPC) activities to improve sound chemicals management. The initiative was supported by funding from the SAICM Quick Start Programme Trust Fund under the project "Assessment and Capacity Building in Chemicals and Chemical Waste Management in Egypt". Capacity-building activities were followed by a six-month implementation period that focused on three selected companies. The pilot projects were accomplished with the technical support of UNEP, ENCPC and international experts. Text Box 3 summarises the activities of the project.

TEXT BOX 3

Overview of RP Implementation Activities in Egypt

1: Awareness-raising workshops for companies
2: Selection of companies for pilot projects
3: Introductory training & self-assessment of selected companies
4: Site visits with international experts
5: Follow-up and implementation support for companies
6: Presentation of results

The implementation of Responsible Production resulted in a significant risk reduction at two chemical producers and it provided input to improving the risk situation of a third company that uses chemicals in its production. The majority of the suggested measures were implemented during the course of the pilot project. Companies recommended that experts would follow up more intensively throughout the RP implementation process.

Activity 1 - Awareness-raising workshops for companies

The RP approach was presented to more than 50 manufacturing companies, as part of two SAICM workshops held in October 2010, in Sadat City and 6th October City. Four staff members of the ENCPC participated in two capacity-building workshops organised and conducted by international experts. The Responsible Production approach was well-received during the awareness-raising workshops and many companies expressed their interest in participating in the RP exercise. Following the workshops, some of the participants even started to independently apply elements of the RP Toolkit.

Responsible Production is indeed an effective tool to put in place an integrated chemicals management system for Small and Medium Enterprises (SMEs). It has substantial added value for the prevention and control of chemical accidents.

Eng Hanan El-Hadary
Director, Egypt National Cleaner Production Centre

Activity 2 - Selection of companies for pilot projects

Three enterprises were selected for pilot projects from among the participants in the workshops: Chimi Art, Eagle Chemicals, and GMC. The companies were chosen based on the following criteria:

- Company size (SMEs);
- Representative industry sectors that could allow for multiplication potential;
- Fair amounts of chemicals are used (no pure engineering/mechanical companies);
- The need for chemical hazard management (insufficient awareness and risk management systems); and
- The presence of production lines and storage facilities.

Activity 3 - Self-assessment of selected companies

In the period between the introductory training and the site visits, each of the selected companies was asked to complete a preparatory assignment consisting of the dashboard worksheets from the RP Framework booklet as well as a process flow diagram (Tool 1.1) and the chemical inventory and hazard classification (Tool 1.2). This self assessment approach is considered as a starting point for the implementation of RP. It also helps in preparing for the subsequent site visits, as having this information increases the potential that the site-visits will lead to useful and concrete results.

Activity 4 - Introductory training and site visits with international experts

On-site activities were conducted approximately six weeks after the workshops (5-7 December 2010). The companies received introductory training on the goals and method of UNEP's RP Approach prior to the site visits, which were carried out in a collaborative way by the ENCPC, UNEP, international experts (BiPRO, GIZ, ASSIST) and company representatives. Each site walk-through followed the flow of chemicals from off-loading to process, storage and loading of final product, looking at potentially risky operations. Taking into consideration the findings of the companies' self-assessment, process flows were systematically analysed with the aim of identifying the critical safety issues on-site. All of the companies cooperated enthusiastically and guided the team through their storage and production facilities. They were receptive to the idea of RP and anticipated the benefits. This can be considered a result of the ENCPC's trust-building efforts.

During the on-site visits, risks were identified and documented in a table (an example of the format used for this is set out in Table 9. After the walk-through, risk reduction measures were developed in discussion with site personnel and experts. They were further elaborated in site-specific summary reports which were prepared by ENCPC for each company.

Table 9: Format for the Summary of On-site Assessments in Egypt

Process steps / Storage area	Chemicals	Hazard / Risk	Frequency/ Severity[28]	Priority	Risk reduction measure

This systematic approach has proven to be useful for achieving results within a relatively short period of time. Provided that companies are sufficiently prepared in advance, and closely follow the methodology outlined in the RP Toolkit, a half-day company visit may be sufficient for the identification of the most relevant risk reduction measures.

Activity 5 - Follow-up and implementation support for companies

After the site visits, the companies continued to perform cost-benefit analyses related to the risk reduction measures and eventually implemented appropriate measures with the support of ENCPC. The results of the site visits were summarised and documented in such a way that it helped prioritise risk reduction actions, leading to implementation of the most critical measures during a six-month period.

Implementing most risk reduction measures did not require major financial investments as companies started with easy-to-implement "low hanging fruits", such as, for example, reorganising warehouses, better housekeeping or improved procedures, and education/training. Such low-cost and easy-to-implement measures have the potential to significantly contribute to the overall safety of the operations. Efficient implementation of risk reduction measures was observed to depend on continuous supervision and external technical support.

Activity 6 - Presentation of results

The companies that signed up for the first pilot projects were given the opportunity to present their experiences with RP within the framework of the 2nd advanced SAICM chemical management training workshop held in Cairo in May 2011. Participants included approximately 70 representatives, from both industry and academia.

The companies (Chimi Art, Eagle Chemicals, and GMC) reported in detail how RP was implemented including the initial technical support and training sessions, the on-site visits, the identification and implementation of appropriate risk reduction measures, and follow-up activities. Based on these presentations, it was generally agreed that Responsible Production significantly improved the management of chemical risks, and was considered to have the potential to lead to economic, environmental and social benefits.

[28] The assessment of the severity of the impacts in an accident situation and the likelihood of the identified accident situations taking place is based on tool 1.3 of the Responsible Production Toolkit. Scales of 1-5 are used for both parameters, where a severity of 1 refers to negligible and 5 catastrophic and frequency of 1 refers to practically impossible and 5 to frequent. Refer to pages 20-21 of Responsible Production Toolkit.

Company Case Study: Chimi Art

Chimi Art is a small family-run chemical company with around 15 employees that produces ferric chloride along with corrosion inhibitors, additives for heavy fuel, and additives for boiler water treatment as well as caustic soda and sulphuric acid of lower concentration. The company operates a batch production. The majority of work processes are conducted manually. The company also operates an off-site storage area, located some 500 metres away from the main production site, within the same industrial area (6th October City). Given that a new, largely automated plant will be set up in the near future, investments in equipment and processes in the old facility had recently been reduced to a minimum.

PICTURE 5

Situation at Chimi Art before (left) and after (right) RP implementation

(Source: Egypt NCPC)

RP pilot project: Situation before versus situation after implementation

Before the RP activities were initiated, the management of Chimi Art had been well aware of possible risks related to their on-site production processes. There were particular concerns about the situation during the "chlorination" process of ferric chloride production and the related presence of chlorine gas on-site.

During the site visit, a number of industrial risk scenarios for possible accidents were identified and carefully documented. These scenarios, which concern different locations and process steps, are summarised in Table 10. Typical risks concerned spills, leakages and mishandling. The evaluation of hazards and risks highlighted the urgent need for immediate action in relation to a few significant risks that were identified.

Table 10: Analysis of Possible Risk Scenarios at Chimi Art

Process steps	Chemicals	Hazard / Risk	Frequency / Severity[29]	Priority	Risk reduction measures
Dilution of sulphuric acid (80% to 50%) and caustic soda (from 48-50 % to 30-35%) with water	sulphuric acid caustic soda				
Offloading		Leakage Spills Mishandling	2/3		Awareness of the need for personal protection (*e.g.*, form with boxes to be ticked by workers that personal protection equipment has been provided, that they are aware of risks, that training has been received)
Filling of tank			2/3	Yes	
Adding water			2/2		
Stirring/circulation			2/2		
Filling of containers with final product			2/2		
Production of ferric chloride	hydrochloric acid (waste, diluted); iron scrap				
Offloading		Leakage, Spills, Mishandling	2/2		Awareness for personal protection
Storage on site			2/2		
Transport to reactor			2/2		
Reaction			3/2		
Storage of final product			2/2		
Packaging			2/2		
Production of ferric chloride	Chlorine				
Offloading/Storage		Leakage	2/3	Yes	Gas detector
Injection			2/3		Control circuit
Replacement of tubes			3/3		Gas detector; daily checks on leakage Regular replacement of gas tubes Good maintenance of equipment
Empty container removal			2/2		Gas detector

PICTURE 6

Situation at Chimi Art before (left) and after (right) RP implementation

(Source: Egypt NCPC)

By using the Responsible Production approach, Chimi Art was able to identify risks outside of their core production processes. For example, the RP methodology highlighted the necessity to consider off-site operations, including the off-site storage area and transport between the off-site and on-site operations. As part of the assessment, the storage area was considered to present a critical hazard hotspot: an accident with the concentrated hydrofluoric acid within the storage area has the potential to result in catastrophic impacts for its surroundings. A summary of the assessment of the storage area is shown in Table 11.

Table 11: Off-site Storage Area at Chimi Art: Analysis of Potential Risk Scenarios

Off-site Storage area	Chemicals	Hazard / Risk	Frequency / Severity	Priority
Approximately 1,000 m^2 200-300 tons	Hydrazine, hydrofluoric acid etc.	Leakage, explosion, fire Access of unauthorised persons Impact on human health and the environment	2/3-4	Yes
Transport to production site	Various	Spills, Fire	2/3	Yes

As a result of the exercise, Chimi Art began labelling their chemical containers (see Figures 5, 6 and 7 providing photos of the situation at Chimi Art before and after RP implementation). All of the suggested measures were also implemented (see Table 12), including a focus on raising awareness of risks, better use of PPE, and controlling the risks related to off-site operations. Chimi Art judged that, as most of the actions taken did not require noteworthy financial contributions, there was no need for cost estimates based on the accident scenarios.

[29] This methodology is described in the Responsible Production Toolkit, Step 1

Table 12: Identified Risk Reduction Measures at Chimi Art

Identified Risk Reduction Measures
Area 1: Dilution of sulphuric acid and caustic soda
Place sheet for PPE usage
Raise awareness for risks of all chemicals used
Area 2: Production of ferric chloride
Raise awareness for PPE
Check leakage problems and good maintenance for the equipments on a daily basis
Area 3: Storage Area
Establish a designated storage area for each chemical and ordering system
Comply with storage requirements for hydrogen fluoride and concentrated hydrazine, including installation of locked storage and protection against sunlight
Area 4: Transport to production site
Designate and train drivers and establish proper transportation conditions (*e.g.* blocking of road traffic)
Task 5: General Task
Establish a cross-cutting personnel for chemical safety and regular awareness raising

Obstacles at Chimi Art

The transfer of operations to a new production plant in the near future meant that Chimi Art did not consider implementing measures that would require significant financial expenditures. In addition, the management was reluctant to engage with some stakeholders fearing the release of information, but they were open to working with chemical suppliers. The fact that the management was unwilling to include additional stakeholders hindered a wider RP success and its potential dissemination.

Lessons learned at Chimi Art

Implementing Responsible Production in Chimi Art showed that the methodology can be applied for a small company working with batch production and various processes. The company's previous risk reduction activities helped in designing the required measures to minimise accidents.

The project also showed why RP encourages looking beyond the core production processes: the biggest risks may sometimes be found in off-site operations. In this case, it was essential to include the off-site storage of chemicals in the analysis.

The commitment of the management to support the RP approach was considered helpful for the identification of hidden risks and the quick implementation of measures. Having technical support from the ENCPC staff was well-appreciated. The international experts participating during the on-site visit stressed the need for action and accelerated implementation.

Company Case Study: Eagle Chemicals

Eagle Chemicals is one of the largest producers of resin and polymer products in Africa and the Middle East, with approximately 250 employees. The main lines of production are water-based chemicals (polymers) and solvent-based chemicals (resins). The company site is divided into three distinct areas: the alkyds production line, the polymers production line, and the warehouses. The exercise focused on the warehousing operation, due to time limitations and the size of the company site.

RP pilot project: Situation before versus situation after implementation

At the start of the RP pilot, Eagle Chemicals was committed to fulfilling safety and environmental standards following the example of European regulations. The company was already complying with the REACH regulation for all the relevant chemical products that it exports to Europe.

A site visit to the storage areas was performed in collaboration with ENCPC, UNEP and international experts (BiPRO, ASSIST and GIZ) to identify the risk reduction priorities of Eagle Chemicals.

The team performed a systematic analysis of the process flow from off-loading of raw materials, through to transport, warehousing, temporary storage and loading of final product. This was accompanied by a thorough site walk-through to identify risks associated with warehousing. The analysis provided the company representatives a perspective on simple, no-cost or low-cost information management and dissemination measures that can be taken at the site level in relation to warehousing.

The companies' storage areas were split into tank farms (A) and (B), raw materials (C), and polymer finished goods (D). Other, unspecified storage areas were labelled outside warehouse area (E) for the purpose of the exercise. Based on this classification, the chemical inventory was correlated to the respective storage areas. The different storage areas were visited to identify risk scenarios. During the visit, additional storage areas were identified (which were labelled for purpose of this exercise as: underground storage (B2); and temporary storage outside (F1), (F2) and (F3)).

Throughout the on-site visit, potential accident risk scenarios were identified and documented for different locations or process steps. The results are summarised in Table 13. The typical risks identified during the exercise concerned spills and leakages. The risks related to potential fire and explosion at the storage areas for solvents (xylene, white spirit and toluene based chemicals) highlighted the urgent need for immediate risk reduction actions, as no adequate firefighting plans existed on-site prior to the exercise. Moreover, major concerns were raised with regard to insufficient off-site preparedness for emergencies at the municipal level and the corresponding response capacity.

Table 13: Analyses of Possible Risk Scenarios at Eagle Chemicals

Warehouse	Hazard / Risk	Frequency / Severity	Priority
Tank farm A soya oil offloading and storage	Overfilling; spills (no automatic filling system for tanks; daily fillings)	4/1	
F1 (close to A) – temporary outside storage for toluene/xylene	Spills Fire (open drums of toluene/xylene; poorly labelled)	4/3 3/4	Yes
Tank farm B1 xylene, white spirit, toluene offloading and storage (underground pipes and tanks)	Explosion; fire during offloading Underground leakage Overfilling of tanks	3/3	Yes
Tank underground B2 VAM storage of monomer is temperature sensitive	Leakage; reaction / fire	3/3	
F2 (close to B2) - temporary storage outside VAM drums	Reaction / fire	2/2	
Raw material C Storage of various chemicals; see assignment in chemical inventory in particular TDI[30] and monomers	Leakage; spills / reaction / Fire	2-3/4	Yes
Polymer finished D	None anticipated		
Outside warehouse area E Miscellaneous chemicals; partly temperature sensitive F3 temporary outside storage between C and D	Fire / reaction	2/3	

Immediately after the site visit with international experts, the management of Eagle Chemicals began implementing a series of concrete measures which are summarised in Table 14. (*e.g.*, eliminating temporary storage, introducing level controls to new tanks etc.). Other suggested measures, including those that required investment (*e.g.*, replacement of underground tanks) or stakeholder consultations *(e.g.*, contact with local fire brigade) were postponed due to conflicting company priorities.

[30] Toluene Diisocyanate

Table 14: Identified Risk Reduction Measures and Implementation at Eagle Chemicals

Identified Risk Reduction Measures	Implemented measures
Area 1: Temporary outside storage for toluene / xylene	
Cover and label drums	Temporary storages around the alkyd factory removed to one intermediate storage area.
Establish designated storage area	
Area 2: Tank farm B1 (xylene, white spirit toluene)	
Provide intact tubes and valves for off-loading	New tanks with capacities up to 400 Ton and a level control and a fire fighting foam line were installed.
Provide an intact gas exchange system for truck	
Install overfilling protection, *e.g.*, empty tank available	
Visible labels / colour codes for tank	
Area 3: Tank underground B2 (VAM)	
Replace all underground tanks with stainless steel tanks	Postponed due to company priorities
Require regular surveillance of cooling systems for underground tanks	
Area 4: Temporary storage outside (F2 close to B2)	
Survey storage conditions of outside storage of drums (temperature control)	Temporary storage outside the polymers factory was removed to one intermediatve storage area. Drums are only requested as needed to charge the batch.
Area 5: Raw material C	
Coordinate with suppliers on: handling of TDI in case of spillage, accident, update MSDS for chemicals	TDI drums placed next to the drain of the warehouse and within a suitable distance from forklift pathways. Directions for forklifts were defined.
Label drums clearly and visibly and ensure that wooden pallets are intact	
Install a drainage system in case of spills or leakage	
Designate storage areas through an order system	
Analyse the degree of over storage	
Define driving direction for fork lifters inside the warehouse (e.g,. ground labelling)	
Improve drainage system in case of spills or leakage	
Mark access to fire extinguishing system	
Coordinate with internal and local fire brigade (in particular as regards accidents during night) regularly	
Area 6: Outside warehouse area E (miscellaneous chemicals)	
Apply temperature control / surveillance to area	Postponed due to company priorities
Apply an order system for storage, designated location, separation of chemicals	
Raise awareness of proper fire extinguishing media	

PICTURE 7

Situation at Eagle Chemicals after RP implementation

(Source: Egypt NCPC)

Obstacles at Eagle Chemicals

Due to the company size and time constraints, not all production lines and storage areas were considered within the pilot project. While a number of measures for the storage area were implemented quite fast, there remained risks that originated in the other areas of the company which were not part of the pilot project. Unfortunately, a serious accident in one of the production lines took place that might have been prevented if RP had been extended to that production line.

Although the company contacted suppliers in order to get further advice related to storage conditions and measures required in case of leakage or spills, the company did not consider a wider stakeholder engagement as a priority.

Lessons Learned at Eagle Chemicals

The company was easily convinced about the benefits of RP. Some key measures were quickly implemented without any further support by external experts. See Picture 7 showing the situation after RP implementation.

The occurrence of a chemical accident at one of the production lines that were not considered within the pilot project at Eagle Chemicals demonstrates the importance of choosing a holistic approach, covering all company areas.

Considering risk reduction from a RP perspective highlighted the need for consulting stakeholders, including the local fire brigade. Whereas this was seen as a low cost activity, the company decided not to move forward with it at this time due to other priorities (see Table 14).

The ENCPC appreciated the continuous external technical support to companies that are implementing RP for the first time. Stronger support for the management with regards to stakeholder engagement would likely increase the effectiveness of RP activities.

Company Case Study: GMC

GMC is a medium sized company that manufactures household equipment for the Egyptian market. Being primarily a mechanical/ engineering company, the amount of chemicals used is relatively small. The main products of GMC include washing machines, gas cookers, water heaters and insect killers.

RP pilot project: Situation before versus situation after implementation

The company had developed a business profile that is environmentally responsible, with ISO 9001 and ISO 14001 certifications. The company was also known for its interest in Corporate Social Responsibility activities.

A site visit by a team consisting of experts from ENCPC, UNEP, BiPRO, GIZ, and ASSIST served to identify risk scenarios that could lead to potential accidents. These risk scenarios, along with the suggested corresponding risk reduction measures, were documented for different process steps and locations as summarised in Table 15. Typical risks concerned spills, leakages and mishandling of chemicals.

Table 15: Analyses of Possible Risk Scenarios at GMC

Process step	Chemicals	Hazard/ Risk	Frequency/ Severity	Priority
Offloading performed by fork lifters outside the storage area	Various powders, acids including liquids such as polyols, boric acid or cyanates	Spills, leakage, reactions	2/2-3	
Chemical storage area				Yes
Transportation of chemicals to various production lines performed by fork lifters				
Foam injection	Polyurethane and methylenediphenyl diisocyanate in Barrels		3/2	Yes
Pre-treatment, cleaning and rinsing	Diluted acids; tensides; diluted alkaline chemicals		2/2-3	
Powder coating	Various paints		2/2	
Pickling, galvanisation	Cyanates, diluted acids		3/3	Yes
Enamel, milling	Quartz powder		2/2	
Plastics, extrusion	Plastics		2/3	Yes

Generally, the proposed measures to address these risks did not involve significant costs and, thus, were promptly implemented. The risk reduction measures are summarised in Table 16 below. Picture 8 illustrates the situation before and after implementation of RP measures.

Table 16: Identified Risk Reduction Measures at GMC

Identified Risk Reduction Measures
Area 1: Chemical Storage Area
Reorganise storage area
Establish designated areas taking the chemical properties into account
Area 2: Foam Injection
Raise awareness for PPE (*e.g.*, form with boxes to be ticked by workers that PP equipment has been provided, that they are aware of risks)
Ensure proper handling of empty barrels
Area 3: Pre-treatment, Cleaning and Rinsing
Install collection basins
Area 4: Pickling and Galvanisation
Raise awareness for personal protection equipment
Establish a proper drainage system
Restrict access to chemicals (cyanides) storage
Plan to shift to non-cyanide galvanisation
Area 5: Enamel and Milling
Verify that quartz bags in use are closed to prevent dust in the working hall
Store quartz powder only in designated areas
Raise awareness for personal protection

PICTURE 8

Situation at GMC before (left) and after (right) RP implementation at the Cyanide Storage Area and Foam Injection Unit

(Source: Egypt NCPC)

Obstacles at GMC

Similar to the situation at the other Egyptian companies participating in the Responsible Production pilot projects, the management appeared reluctant to engage external stakeholders.

Lessons learned at GMC

This project showed that Responsible Production is not only for chemical producers; it can significantly improve the management of chemical risks even in companies that employ comparatively small amount of chemicals. Significant improvements can be made without an extensive investment of time and resources. Generally, cost-effective measures can therefore be implemented quickly and without prior cost benefit analysis; such analyses may become useful when larger financial investments may be involved.

EGYPT
SUMMARY OF LESSONS LEARNED

The participating Egyptian companies cooperated enthusiastically and openly. Due to the ENCPC's trust-building efforts with the companies, they were receptive to the idea of RP and its anticipated benefits.

On-site visits supported by international experts constituted a key component of the pilot projects in Egypt. Where companies were sufficiently prepared for the visit and made all relevant information available, even a brief half-day company walk-through sufficed for identifying the most relevant risk reduction measures. However, the length of a site visit must be scaled to the nature and extent of risks.

Although most immediate risk reduction measures identified in the pilot companies did not require major financial investments, these measures can significantly contribute to the overall safety of the sites. The commitment of the company management (board) helps in implementing the risk reduction measures. Summarising the results of the site visits in a simple table format prioritising suggested actions can help obtain management commitment. However, if management priorities are not focused on matters of safety, external technical support and continuous follow-up may help the company to follow through with the recommendations.

The Egyptian pilot cases showed that through Responsible Production companies can be encouraged to look beyond their core production processes. Some of the biggest risks may be found in off-site operations (such as warehouses) and on-site temporary and undesignated chemical storage areas.

One of the pilot projects raised a concern about the sufficiency of emergency preparedness at the level of the industrial area. Through RP, the company became aware of the importance of having a dialogue with the local fire brigade.

SRI LANKA

Activities and Achievements

In close collaboration with UNEP, the NCPC in Sri Lanka integrated the concept of Responsible Production in a project, which also covered resource efficiency (RERP, *Resource Efficient and Responsible Production*).

The project began after a capacity building workshop, organised by UNEP and conducted by international experts, in Colombo, Sri Lanka (June 2010)[31].

The Sri Lankan NCPC selected two companies for the pilot projects, one manufacturing footwear involving rubber and synthetic compounds and the other manufacturing paints.

Following the systematic identification and evaluation of potential hazards as outlined in the RP Toolkit, immediate risk reduction measures were implemented by both companies. However, due to technical and financial constraints, some risks still remained to be addressed. Generally, the project was very well-received by the selected participants and strongly encouraged intensive efforts to further disseminate UNEP's Responsible Production approach. Text Box 5 summarises the activities of the project.

TEXT BOX 5

Overview of RP Implementation Activities in Sri Lanka

1: Awareness-raising workshop
2: Selection of two SMEs for pilot projects
3: Introductory training and self-assessment of selected companies
4: Site visits
5: Follow-up and implementation support for companies
6: Dissemination of RP

Activity 1 - Awareness-raising workshop

The pilot project built on a Regional Workshop on Resource Efficiency and Responsible Production organised by UNEP, in Colombo, Sri Lanka, in June 2010. During this workshop, the NCPC was trained on the use of the RP Toolkit.

Activity 2 - Selection of two SMEs for pilot projects

The NCPC selected companies for the initiation of pilot projects on the basis of:

- Company size: the tools have been developed for SMEs;

[31] Please refer to Chapter 3 for further information.

Resource Efficient and Responsible Production (RERP) has helped the small industries in Sri Lanka to look at the triple bottom line management in a new perspective. The pilot study revealed that many areas in an industry, specially related to risks, which usually are unnoticed come to light through the use of these simple and easy to use tools and techniques. The special achievement in the pilot exercise was the interest and the motivation created among the operational staff on the aspects of risk mitigation. I strongly believe that RERP should be broadly applied in all SMEs in the Asian region industries.

Eng V R Sena Peiris
Director
National Cleaner Production Centre, Sri Lanka

- Ownership structure: Sri Lankan companies tend to have fewer management systems; and
- Economic position: investment of resources should be made in promising industries.

On the basis of these criteria, the Sri Lankan NCPC identified two medium sized manufacturing enterprises whose production is greatly dependant on the use of chemicals. Both are 100% locally-owned enterprises and significantly contribute to the country's economic growth. Hence, successful implementation of RP and RERP in these companies was assumed to have an impact on sustainable development in Sri Lanka.

Activity 3 - Introductory training and self-assessment of selected companies

A two-day training workshop was organised by the NCPC for the representatives of the two selected enterprises. Shortly before NCPC's on-site visits, the selected companies were given a preparatory assignment, comprised of two RP tools: Tool 1.1 (prepare a process flow chart) and Tool 1.2 (chemical inventory and hazard classification). Using these tools, the companies generated process flow diagrams and chemical inventories.

Activity 4 - Site visits

The preparatory assignments were used as a starting point for the on-site visits that were conducted in close collaboration between representatives of the selected companies and NCPC experts. Process flows were systematically analysed with the aim of identifying all the potential risks posed by the companies' chemicals use and handling. The results of the on-site assessments were documented and evaluated in a table (see Table 17), enabling the selected companies to prioritise their actions towards improved hazard management systems.

Table 17: Sri Lankan Template for the Elaboration of Severity and Frequency of Different Accident Scenarios and Locations

Impact Areas / Location	Impact on workers health	Impact on community health	Impact on land use, agriculture and fisheries	Impact on water resources	Impact on quality of air	Impact on company image	Impact on site facilities	Impact on transport infrastructures	Impact on community and social infrastructures	Severity	Frequency
	a	b	c	d	e	f	g	h	j	a-j	
Raw material loading / transport / unloading											
Small Chemical Room											

Activity 5 – Follow-up and implementation support for companies

The implementation of appropriate risk reduction measures and the related cost-benefit analyses were conducted during the follow-up phase. Experts from the NCPC assisted the individual companies with this process. Project progress was supported by follow-up visits.

Activity 6 - Dissemination of RP

The Sri Lankan NCPC is using the experience of the pilot projects in promoting the multiplication of the RP implementation in at least five to ten companies. Once experience from these companies is collected, the NCPC intends to organise a seminar to disseminate the results. In the meantime international experts returned to Sri Lanka and provided further capacity building in the context of RP.

Company Case Study: Samson Compounds (Pvt.) Ltd

Samson Compounds (Pvt.) Ltd is the leading footwear manufacturer in Sri Lanka. Founded in 1962, it is now integrated into the DSI Group that significantly contributed to the national economic development.

Samson Compounds is divided into different operational units, some of them located away from DSI's headquarters. The operational units comprise: Weighing & Mixing; Sheeting & Press; Ethylene Vinyl Acetate (EVA); and Recycling.

RP pilot project: Situation before versus situation after implementation

The company has conducted awareness and training programmes with the assistance of the external experts about four times a year. However, these trainings focus on productivity enhancement rather than on risk management. Regarding the latter aspect, activities had been limited to in-house training courses at irregular intervals and were considered not to meet adequate standards.

RP activities were targeted at all operations of Samson Compounds (Pvt.) Ltd. To ensure an

efficient implementation of the RP approach, a project team consisting of fourteen employees was established, representing various company operations, ranging from the director to production, engineering and security managers, and store assistants.
Following introductory training and self assessment, an on-site visit led to the identification of five hazard hotspots and 39 accident scenarios at various process steps (summarised in Table 18). The thorough consideration of these accident scenarios resulted in the development of a detailed series of more than 100 risk reduction measures. Prioritising the risks identified those measures that had to be implemented immediately.

Table 18: Analyses of Possible Risk Scenarios at Samson Compounds

Process step	Chemicals	Hazard / Risk	Frequency / Severity	Priority
Raw material loading, transport, unloading	Different raw materials	Chemical explosions due to road accidents	2/3	
		Release of toxic chemicals due to road accidents	2/4	Yes
		Fire from flammable chemicals during road transportation	2/4	Yes
		Formation of harmful gases due to chemical fire	2/4	Yes
		Release of contaminated fire fighting water from fires occurring during chemical transport	2/4	Yes
		Leakage of hazardous chemicals during loading, unloading and / or transportation	2/2	
Raw material storage, Drum yard	Different raw materials	Emission of toxic / irritant gases and /or fumes during handling of chemicals	2/2	
		Emission of dust during issuing and handling of chemicals which are in powder form	2/3	
		Chemical explosions (blowing agents), dust explosions	3/4	Yes
		Fire from flammable chemicals due to lightning, etc.	2/3	
		Formation of harmful gases during chemical fire	2/3	
		Release of contaminated fire fighting water from fires occurring chemical transport	2/3	
		Leakage of hazardous chemicals from stores during issuing and handling (through the operations of forklifts)	2/3	
		Accidents caused by the operation of forklifts in bad condition	3/3	
		Accidents caused deliberately or unintentionally by poor access control of unauthorised persons	2/2	
		Accidents due to shortcomings in working environment	4/1	
		Accidents while working in the cool room	3/1	

Process step	Chemicals	Hazard / Risk	Frequency / Severity	Priority
Small Chemical room		Dust explosions	3/3	Yes
		Accident caused by consumption of drinking water in rooms containing hazardous chemicals	3/3	Yes
		Emission of dust during weighing and packing	4/3	Yes
		Emission of toxic / irritant gases and / or fumes	4/3	Yes
		Formation of harmful gases due to chemical fire	3/4	Yes
		Release of contaminated fire fighting water from fires occurred at chemical transports	3/4	Yes
		Leakage of hazardous chemicals during handling within the stores and /or transportation	4/3	Yes
		Fire caused by improper electrical wiring of equipment	3/3	
		Accidents caused by poor housekeeping practices and poor condition of working environment	3/3	
		Increased health risks due to the absence of proper PPE	4/3	
Production Line 1, 2 & 3 (Weighing & Mixing)	Various chemicals	Dust explosions	3/3	Yes
		Emission of toxic / irritant gases, dust and / or fumes	4/3	Yes
		Formation of harmful gases due to chemical fire	4/3	Yes
		Release of contaminated fire fighting water from fires occurring during chemical transport		Yes
		Leakages and spills of hazardous chemicals during bulk chemical weighing and processing	4/3	Yes
		Accidents caused by poor housekeeping practices and shortcomings in working environment	4/3	Yes
Milling, Calen-daring and vulcan-ising	Various chemicals	Dust explosions	3/3	Yes
		Inhalation of dust during loading of chemicals into Banbury machines	5/3	Yes
		Inhalation of irritant fumes generated during milling operation of some compounds	4/3	Yes
		Inhalation of irritant fumes generated during calendaring operations	4/3	Yes
		Inhalation of irritant fumes generated during vulcanising operations	4/3	Yes
		Inhalation of irritant fumes generated during unloading of vulcanised compound	4/3	Yes
		Emission of toxic or irritant gases, dust or fumes when unloading vulcanised compounds	4/3	Yes

After identifying the priorities, the company went on to generate a detailed list of the most relevant stakeholders. Their subsequent engagement proved to be important for identifying and addressing chemical risks in an appropriate way.

As a result of the RP activities, a wide array of measures was implemented, which contributed to an improved control of chemical risks on-site (see Table 19). Various awareness-raising programmes (*e.g.*, covering emergency preparedness, occupational safety and health) were conducted to create a lasting impact on corporate safety issues including programmes on risks for all operators. In addition, to achieve an effective and appropriate emergency response, an on-site emergency plan was established.

Table 19: Risk Reduction Measures and Implementation at Samson Compounds

Accident Scenarios	Implemented Risk Reduction Measures
Raw material loading, transport, unloading	
Leakage of hazardous chemicals during loading, unloading and / or transportation	✳ Bulk chemicals in powder form are transported on pallets and unloaded with the pallets to prevent damages to bags, and to avoid spillages. ✳ Leakages through containments at generator and boiler areas have been rectified.
Raw material stores, Drum yard	
Leakage of hazardous chemicals from stores during issuing and handling (through the operations of forklifts)	A device similar to grab-o-matic has been made and used in handling barrels.
Accidents caused by the operation of forklifts which are unfit for driving	Identified defects have been corrected.
Accidents that may be caused deliberately or unintentionally by the entry of unauthorised persons into the premises	Entry is now restricted, and gate is open only for authorised persons.
Accidents while working in the cool room	An emergency portable torch has been provided. Other actions to be followed.
Small Chemical Room	
Accident situations caused by consumption of drinking water in rooms containing hazardous chemicals	An alternative place has been provided outside the small chemical room.
Fire that may be caused due to improper electrical wiring of equipment	Electrical wiring corrected.
Accidents that may be caused due to poor housekeeping practices and shortcomings in working environment	Housekeeping has been improved.
Accidents that may be caused due to non-availability of some PPE	Required PPE have been provided, and are being used by the employees in the department.

Accident Scenarios	Implemented Risk Reduction Measures
Milling, calendaring and vulcanising	
Inhalation of irritant fumes generated during milling operation of some compounds	Operators have been provided with required PPE, and use them properly.
Leakages and spills of hazardous chemicals during bulk chemical weighing and processing	Sizes of the bags have been reduced from 50 kg to 25 kg bags, making it easy to handle, causing less or no spill or dust.
Accidents that may be caused due to poor housekeeping practices and shortcomings in working environment	Housekeeping has been improved.

PICTURE 9

Situation at Samson Compounds (Pvt.) Ltd before (left) and after (right) RP implementation

(Source: Sri Lanka NCPC)

Obstacles at Samson Compounds

Convincing external stakeholders to commit to the idea of RP sometimes appeared difficult, particularly for those that are not directly linked with the company. Due to time constraints, the optimisation of stakeholder engagement in accordance to the integrated RP principles (*e.g.*, addressing the whole value chain) has not yet been further pursued.

For Samson Compounds, the calculation of one-off expenses caused by the restructuring process (new practices) was generally feasible, whereas the determination of running expenses and therefore the calculation of the return on investment (ROI) proved difficult.

Lessons learned at Samson Compounds

The strong commitment of the top management to support RP was essential for the success of this project. RP activities at Samson Compounds are considered as setting an example, first and foremost for other subsidiaries within the DSI Group, but also at the national level. In this regard, stakeholder engagement proved to be of key significance for identifying and addressing chemical hazards and risks. It was expected that, as a result of the project, an atmosphere of greater cooperation and rapport with the stakeholders will be built, creating a more conducive environment which may help further boost the reputation of the company.

In addition:

- Given the broad range of educational backgrounds of the company's personnel, specifically designed training courses were considered valuable for the creation of long-lasting effects.

- Many risk reduction measures, such as awareness-raising, providing PPE or the installation of spark arrestors, do not require significant financial investments.

The RP approach proved to be a valuable tool for supporting appropriate chemicals safety management, thereby complementing shortcomings of the national legal requirements.

Picture 9 helps to illustrate the achievements in Samson Compounds.

Company Case Study: Silicone Coatings (Pvt.) Ltd

Silicone Coatings was founded in 1979 as a small production unit within the municipal area of Matara, at the Southern tip of Sri Lanka. Since then, the company has become one of the leading paint manufacturers in the country with about 110 employees, currently holding a local market share of around 20%.

RP pilot project: Situation before versus situation after implementation

Due to its international relations, the management of Silicon Coatings is well aware of the latest developments in the industry and supports capacity-building activities. For instance, all employees are encouraged to attend external training courses to enhance their technical knowledge and operational capabilities. Newly-recruited employees are trained on the job under the authority of their respective superiors.

However, it turned out that, apart from the members of management, the majority of employees had only a very limited awareness as to the information on MSDSs and the potential impacts on their health or the environment from the handling of chemicals.

To implement the RP approach, a project team comprising nine employees from various corporate divisions was established,

with a range of employees including store-keepers, product executives, safety officers and assistant managers as well as the R&D Manager.

Following the introductory training and the self-assessment, the subsequent on-site visits led to the identification of eight hazard hotspots and 37 risk scenarios for potential accidents at various process steps (summarised in Table 20). Thorough consideration of these risk scenarios eventually led to the development of a detailed series of 81 measures. Prioritisation was used to reveal those hazards and risks that had to be acted upon immediately.

Table 20: Analysis of Possible Risk Scenarios at Silicone Coatings

Process step	Hazard / Risk	Frequency / Severity	Priority
Raw material loading, transport, unloading	Chemical explosions due to road accidents	3/4	
	Releasing of toxic chemicals due to road accidents	3/4	
	Fire from flammable chemicals during road transport	3/3	
	Formation of harmful gases due to chemical fire	3/3	
	Release of contaminated fire fighting water from fires occurring during chemical transport	3/4	
	Leakage of hazardous chemicals during loading, unloading and / or transport	3/3	
Raw material storage, Drum yard	Emission of toxic / irritant gases and /or fumes during handling of chemicals	5/3	Yes
	Emission of dust during issuing and handling of chemicals	5/3	Yes
	Chemical explosion, dust explosion	2/4	
	Fire from flammable chemicals - due to lightning/ vegetation in drum yard/ outside source of fire	3/4	
	Fire in Methanol Storage	2/4	
	Formation of harmful gases due to chemical fire	3/4	
	Release of contaminated fire fighting water from fires occurring during chemical transport	3/4	
	Leakage of hazardous chemicals at the storage area while issuing and handling (forklift operations)	3/3	
	Accidents caused by bad condition of working environment	5/2	
	Accidents caused by the operation of forklifts in bad condition	4/4	Yes
	Accidents caused during movement along chemical handling pathways (especially entry/ exit to production floors) due to poor design and maintenance of the pathways	4/3	
	Accidents caused by poor housekeeping practices	4/3	

Dry Powder Mixing Plant	Dust explosion	2/4	
	Emission of dust while mixing and packing	5/4	Yes
	Fire caused by improper electrical wiring of equipment	3/4	
	Accidents caused by poor housekeeping practices	5/3	Yes
NC Thinner Plant	Chemical explosion (plant is in zone 1 area)	2/5	
	Fire from flammable chemicals due to static charge	2/5	
	Fire from flammable chemicals due to fluorescent lamps with magnetic ballasts	2/5	
	Formation of harmful gases due to chemical fire	2/4	
	Release of contaminated fire fighting water from fires occurring during chemical transport	2/4	
	Leakage of hazardous chemicals in the process area	2/4	
	Accidents caused by poor housekeeping practices	5/2	
Finished Goods Stores	Spilling of solvent based products	3/2	
	Fire from flammable chemicals (solvent based products)	2/4	
	Formation of harmful gases due to chemical fire	2/4	
	Release of contaminated fire fighting water from fires occurred at chemical transports	3/4	
	Fire and explosion due to emission of hydrogen during charging of batteries of forklifts inside the stores	2/3	
Water Based Paint Production Floor (including mixing of chemicals for solvent based products)	Emission of toxic or irritant gases or fumes during mixing	2/4	
	Emission of dust while mixing	2/4	
	Chemical explosion (Nitrocellulose, in solvent based)	2/5	
	Fire from flammable chemicals (solvent based)	2/4	
Solvent Based Paint Production Floor	Emission of toxic or irritant gases or fumes during mixing and filling	2/4	
	Emission of dust while mixing	2/4	
	Chemical explosion	2/5	
	Fire or explosion caused by inappropriate electrical installations (for Zone 1 classified areas).	2/4	
	Fire from flammable chemicals cause by the sparks of fluorescent lamps with magnetic ballasts	2/4	
	Increased health risks due to the absence of proper PPE	2/4	
Research & Development Lab	Fire and explosion caused by inappropriate electrical installations (for Zone 1 classified areas).	2/4	
	Accidental situations during handling of chemicals when working alone (specially after normal working hours)	3/3	
	Fire situations attributed to locating of spray booth close to neighbouring pantry and welding shop	2/4	

Generating a detailed list of most of the relevant stakeholders and their subsequent engagement proved to be useful for both identifying and addressing chemical hazards and risks in an appropriate way.

As a result of the RP activities, a number of measures were implemented, thereby greatly improving the control of chemical risks (see Table 21). Within the framework of the programme, an annual training course was developed, putting an emphasis on occupational safety and health. This approach was designed to create a long lasting impact on corporate safety issues. In addition, for an effective and appropriate emergency response, an on-site emergency plan was successfully established.

Table 21: Risk Reduction Measures and Implementation at Silicon Coatings

Accident Scenarios	Implemented Risk Reduction Measures
Raw material loading, transport, unloading	
Releasing of toxic chemicals due to road accidents; and leakage of hazardous chemicals during loading, unloading and / or transport	Transport system has been improved. Tankers from the sea port in Colombo drive directly to the stores at site for unloading instead of earlier practice of unloading chemicals at Ekala (near Colombo) to be brought to the site in barrels by trucks. Transportation of diesel is also by bowsers (refuelling vehicle) and unloaded at the storage tank, constructed according to the specifications of the Ceylon Petroleum Corporation. Secondary containments have been made in the areas concerned.
Raw Material Storage and Drum Yard	
Fire from flammable chemicals - due to lightning/ vegetation in drum yard/ outside source of fire	Vegetation has been cleared Solvent storage area was exposed to direct sunlight and rain; now it has been protected with a roof.
Accidents that may be caused by the operation of forklifts which are unfit for running	Forklifts have been repaired. The use of forklifts has been reduced and replaced by a truck which now moves chemicals to the production floor from the stores, thus reducing chances of accidents.
Accidents that may be caused due to poor housekeeping practices	Housekeeping practices have been improved. Two employees have been exclusively assigned to look into this matter.
Dry Powder Mixing Plant	
Emission of dust while mixing and packing could eventually lead to a dust explosion	A closed type new filling unit has been purchased, thus minimising emission of dust.
Fire that may be caused due to improper electrical wiring of equipment	Electrical wiring of the equipment has been redone properly.
Accidents that may be caused due to poor housekeeping practices	Housekeeping has been improved.

Accident Scenarios	Implemented Risk Reduction Measures
Leakage of hazardous chemicals in the process area	Leakages have been contained and measures are taken to systematically control pipes, vessels and containments.
Fire from flammable chemicals due to fluorescent lamps with magnetic ballasts	Fluorescent lamps have been replaced.
Accidents that may be caused due to poor housekeeping practices	Housekeeping has been improved.
Finished Goods Stores	
Fire and explosion that may be caused due to emission of hydrogen during charging of batteries of forklifts inside the stores	Battery charging bay has been relocated outside.
Fire from flammable chemicals (solvent based products)	An extension unit with more space for separation of items is under construction, reducing the probability of a fire occurring.
Emission of toxic or irritant gases or fumes during mixing and emission of dust while mixing	A new machine with enclosed type mixing has been purchased minimising emission of fumes.
Solvent Based Paint Production Floor	
Accidental situations during handling of chemicals when working alone, especially after normal working hours	Preventive action has been taken by assigning a minimum of two employees at any given process during periods of operation.
Fire situations attributed to locating of spray booth close to neighbouring pantry and welding shop	A suction system has been installed to minimise risk.

PICTURE 10

Situation at Silicone Coatings after RP implementation
Before: Storage areas missed roofs and ground sealing (pictures not available)
After: Chemical storage yard has been improved. Roofs were constructed and floors were sealed for ground protection. Secondary containments were and will be constructed for some chemical storage tanks.

(Source: Sri Lanka NCPC)

Before: Spillages took place when the trolleys were moving on the metal grill cover of the drain (pictures not available)
After: metal gill is partially covered on the pathways so that no spillage takes place.

Obstacles at Silicone Coatings

The obstacles were similar to those of the company Samson Compounds. Please refer to the previous case study.

Lessons Learned at Silicone Coating

The lessons learned were similar to those of the Samson Compounds. Please refer to the previous case study.

Picture 10 further illustrates how the situation in Silicone Coating improved as a result of the Responsible Production project.

TEXT BOX 6

SRI LANKA
SUMMARY OF LESSONS LEARNED

The Sri Lankan pilot companies implemented the RP process thoroughly in their companies, and hence showcased the value of its systematic approach. Whereas both companies attempted to engage stakeholders, their active involvement was considered challenging due to time limitations. Nevertheless, these cases showed that the companies believe that a more consultative approach will be developed with an atmosphere of greater cooperation. This, in their view, can help further boost the reputation of the companies.

Numerous risk reduction measures were implemented in the Sri Lankan companies as a result of the project, despite limited human and financial resources. Both of the pilot companies regarded calculating one-off expenses relating to the risk reduction measures as a feasible exercise. However, determining running expenses was more challenging. Accordingly, calculating the return on investment (ROI) was proven to be difficult.

CHINA

Activities and Achievements

UNEP's Responsible Production was introduced to representatives of NCPCs in the Asia Pacific Region within the framework of a regional capacity building workshop that was held in June 2010 in Colombo, Sri Lanka. Following this event, the China National Cleaner Production Centre (CNCPC) initiated a project on Responsible Production in two Chinese companies. This project was implemented between September 2010 and April 2011. CNCPC set up a project team to translate the RP Handbook into Chinese and provide support to the companies, and was subsequently supported by UNEP and international experts.

Responsible Production activities in China included workshops, on-site visits, and technical support with respect to implementation of appropriate risk reduction measures. The RP implementation was carried out at these two companies:

- Beijing Zhong Ke San Huan Hi-Tech Co., Ltd. ("Zhong Ke San Huan") and
- Hebei Veyong Bio-Chemical Co., Ltd. ("Hebei Veyong Bio-Chemical").

Generally, UNEP's Responsible Production approach was very well received and significantly contributed to the improvement of chemical hazard management at both participating companies. While one company implemented all identified risk reduction measures, the other company focused on risk reduction measures with little investment costs, due to the upcoming relocation of the production site. However, this latter company committed to considering the identified measures at the new location. Text Box 7 summarises the activities of the project[32].

TEXT BOX 7

Overview of RP Implementation Activities in China

1: Collection of basic information
2: Training
3: Site visits
4: Implementation and follow-up

[32] The RP team recognised that for a good comparison of the safety situation before and after RP implementation, more pictures would have been beneficial. The RP team plans to consider this for future projects.

Responsible Production will help us go deeper into a cleaner way of better controlling chemical hazards. It is a good complementary tool for traditional cleaner production assessment.

Ms. Xiuling YU
Director,
China National Cleaner Production Centre

Activity 1 - Collection of basic information

Prior to the on-site visits, the CNCPC gathered some basic information relevant to the RP performance at the selected pilot companies. The information included:

- Type and quantity of chemical raw materials and products;
- Main production processes;
- Production scale;
- Number of employees; and
- Existing management systems related to safe production or chemical safety.

In order to enhance the applicability of RP tools, CNCPC developed templates, extracted from the Responsible Production Toolkit, for example for the establishment of a chemical inventory and a process flow chart.

Activity 2 - Training

At the pilot companies, the RP tools were explained during a two-hour presentation to company employees which included top managers and directors. The training focused on Tool 1.1 (Prepare a process flow chart), Tool 1.2 (Chemical inventory and hazard classification), Tool 1.3 (Identify health, environmental, social and economic risks), Tool 1.4 (Map the hotspots) and Tool 3.1 (Identify actions for risk reduction).

The training session at one of the companies (Hebei Veyong Bio Chemical) was complemented with an additional event focusing on Hazard and Operability Study (HAZOP), led by Professor Zhao Jinsong from Tsinghua University, which included a so-called 'Risk check along the process flow' by applying the HAZOP tool[33]. The application of this tool was demonstrated to be straightforward and considered a valuable contribution to a deeper understanding of chemical safety issues.

Activity 3 - Site visits

The preparatory assignments were used as a starting point for the on-site visits, which were performed in close collaboration among representatives of the selected companies, CNCPC and Tsinghua University along with additional experts.

The CNCPC project team further supported the participants in elaborating and applying the implementation dash-board in order to evaluate the RP performance level of the companies. Additionally, the best practice checklist provided in the toolkit was used to identify potential actions for the improvement of daily chemical handling and management in the companies.

Activity 4 - Implementation and follow-up

The CNCPC team supported implementation and follow-up. The companies followed clear priorities related to implementation measures. This means that the most important, but not all, suggestions for risk reduction were implemented.

Company Case Study: Zhong Ke San Huan

Zhong Ke San Huan is a SME with about 150 employees. It is a high-technology company engaged in the research, development, manufacture and sales of magnets as well as their application devices. Its main products are sintered Nd-Fe-B magnets, bonded Nd-Fe-B magnets, soft ferrites and electric bicycles. As the leading manufacturer of Nd Fe-B magnets in China and one of the largest in the world, it has entered the high-end Nd-Fe-B magnet application areas of IT, green power and medical care. Typical products are hard disk drives, optical disk drives, wind generators, auto motors and magnetic resonance imaging systems. As their production is directly controlled by the incoming orders, the output is uncertain each year.

RP pilot project: Situation before versus situation after implementation

Zhong Ke San Huan had a comparatively good, all-around chemicals management, including strong awareness of the importance of hazard control and process safety management. However, appropriate tools to address these issues were lacking, and RP was considered to improve the shortcomings and to significantly contribute to long-lasting improvements in chemical hazard management.

For the implementation of RP, a five-member project team was set up, including the general manager, the vice general manager and three production line managers. All of them had a basic idea about RP and the most important tools, which were provided to them in a CD-ROM.

On October 14, 2010, the RP team from CNCPC and a professional from Beijing Electroplating Association visited Zhong Ke San Huan. The company's general manager, deputy manager in charge of production, and chief of safety and environment department participated in the meeting.

The RP team and the general manager introduced the background, process and objectives of RP application. Following a brief introductory training, there was an on-site visit to identify hazard hotspots, which focused on the production lines located in the first floor of the main building. Hazards were identified and documented for the processes and subsequently grouped into four different categories: Health, Environment, Property and Speed[34]. To prioritise, the values assigned for severity and frequency for each hazard were multiplied and the results that exceeded a value of 15 were considered as hazard hotspots. If no value exceeded 15, the two highest values would are defined as hazard hotspots for that specific process step.

Table 22 summarises the results of the analyses. The scores which were given for the severity and frequency of the risk scenarios were set by the company.

[33] The tool may be found in the Responsible Production Handbook Appendix on "Advanced tools".
[34] Where "speed" means the expansion speed of an accident.

Table 22: Hazard Hotspot Analyses at Zhong Ke San Huan

Process step	Danger type	Severity	Frequency	Frequency / Severity
Acid Pickling	Life	5	3	15
	Environment	4	3	3
	Property	2	3	6
	Speed	4	3	12
Electroplating	Life	5	3	15
	Environment	5	2	10
	Property	3	2	6
	Speed	2	3	6

With the support of the project team, five risk scenarios were identified by applying the selected RP tools. For each scenario, one risk reduction measure was developed and implemented by February 2011. The identified risk scenarios and corresponding risk reduction measurement are provided in Table 23.

Table 23: Identified Risk Scenarios and Risk Reduction Actions at Zhong Ke San Huan

Process step	Risk scenario	Action
	Risk of accidents due to inadequate repair of rollers	Define place for damaged rollers to be repaired and add labels with detailed damage information.
Acid pickling	Spillage of waste acid	Provide trays for waste acid collection.
Electroplating	Complicated pipe installations with too many pipe bends which are hard to clean; this produces additional dirt, increasing liquid waste.	Remove useless pipe bends.
	Heavy metal contamination of liquid waste	Provide trays for collecting electroplating solution.
	The copper plating solution is a strong acid; can cause harm to human health when leaked.	Substitute strong acid with weak caustic solution.

As part of the analysis, the company attempted to identify economic and environmental benefits for each of the actions. For all of the risk reduction measures, an environmental benefit was easy to specify. Although economic benefits were difficult to quantify precisely, it was recognised that RP contributes to reducing the cost of equipment maintenance and the cost of raw materials. This analysis is summarised in Table 24.

Table 24: Risk Reduction Measures and Associated Economic and Environmental Benefits at Zhong Ke San Huan

Process	Position	Actions	Economic Benefits	Environmental Benefits
-	-	Set special area for roller repairing, and add labels with detailed damage information	Reduce the cost of reparation of equipments.	Reduce the failure rate of equipment and improve the efficient use of raw materials.
Acid Pickling	Acid Pickling	Add cans for acid collection		Reduce the pollution of acids.
Electroplating	Production line 1,2,3	Remove the useless pipe bends	Reduce the cost of raw materials.	Reduce the leak of raw materials. Reduce the waste liquids.
Electroplating	Production line 1,2,3	Add plates for collecting electroplating solution		Reduce the pollution of heavy metal.
Electroplating	Production line 1,2,3	Use weak caustic solution to replace the strong acid one	300 rmb/ month.	Reduce the use of strong acids. Reduce the pollution of strong acids.

The general opinion of the participants was that the RP Toolkit helped increase awareness of those managers and employees who were trained, to protect the environment and to identify possible chemical hazards. The tools and methodologies were considered to contribute to the improvement of chemical hazards management.

During the project, the company gained new insights about their chemicals and their potential hazards, which caused them to pay much higher attention to them. By preparing the chemical flow chat, the hotspot map and the hazards classification, employees understood where each of the chemicals is used and the location of the hazard hotspots along the production line. As a result, the company Zhong Ke San Huan was able to identify areas which needed more attention in their daily operations.

Obstacles at Zhong Ke San Huan

Zhong Ke San Huan is a small-sized electroplating company and negotiating with the suppliers of some raw materials/chemicals to provide further information about the chemicals proved to be a challenge. The company also found it hard to obtain further information about their materials during the pilot project, which was needed to perform the risk analysis of these raw materials. SMEs have little influence on the large-sized suppliers and customers when they want to include them as stakeholders in the project.

Lessons learned at Zhong Ke San Huan

Zhong Ke San Huan had already completed cleaner production assessments, which had increased the company's awareness of environmental protection and cleaner production issues. Responsible Production provided various tools allowing the company to improve the safety of their production.

The involvement of the local electroplating association was considered an important component that also greatly contributed to the success of the pilot project, especially with respect to improving communication with the companies' representatives and sharing their professional expertise.

The commitment of the top management of the company was very important for the project and made it easy for the CNPC to follow up with the implementation of the risk reduction measures. The managers of the company considered the RP tools very useful for a thorough review of all the chemicals in their production processes and to find opportunities to reduce risks caused by hazardous chemicals. The employees of Zhong Ke San Huan were therefore very interested in the pilot project to apply the RP tools in their company.

Company Case Study: Hebei Veyong Bio-Chemical

Hebei Veyong Bio-Chemical is a modern enterprise engaged in R&D, manufacturing, preparation and sale of bio-pesticides and bio-veterinary drugs. The company has more than 3,000 employees, and produces more than 140 pesticide products and 120 veterinary products. Each production line comprises an entire production process, from raw materials to finished products.

RP pilot project: Situation before versus situation after implementation

The company had already been well aware of the importance of controlling chemical hazards appropriately. The management had established a series of measures, including the provision of chemical safety information (*e.g.*, MSDSs) and training activities as well as measures to improve accident prevention and emergency preparedness (*e.g.*, establishment of double fire doors, emergency phones, eye wash stations, systems to detect toxic gases). Information regarding safety issues had been distributed at various occasions through, for example, lectures, CDs about safety and accidents, and exchange of experience among workers related to small accidents in the company.

In addition, Hebei Veyong Bio-Chemical had established a continuous exchange of information with downstream customers, including retailers and wholesalers, direct distributors and even farmers. This included training on how to use certain pesticides and how to prevent potential risks that may arise from the application of these products. Retailers and wholesalers were organized to pay visits to the production line of the company to strengthen their understanding and knowledge of the products. A free emergency hotline had been established for customers for situations when professional assistance was needed.

However, it was generally agreed that better and more in-depth management tools were required to monitor and improve risk management. The company's managers believed that RP provides them with the set of tools they need for further development of risk management.

On October 29, 2010, the RP team visited the company and met the deputy general manager, the chief of department of safety and environmental protection, the chief of production, and the directors of various production lines.

The visit started with a general introduction to the RP project and the purpose of the visit. The opening was followed by a brief introduction by the CNCPC experts regarding

the RP process and this pilot project.

During the first on-site visit, nearly 30 employees of Hebei Veyong Bio-Chemical participated in the general training on Responsible Production. Selected professional staff members from the company have been involved in the application of the tools, including staff from the department of environmental protection and safety management, the department of procurement, and employees of the Avermectin[35] production line.

Due to time constraints, the pilot project was limited to one production line where approximately 70 workers produce about 6 tons of Avermectin annually. Hazards were identified and documented for various processes and subsequently grouped into four different categories: Health, Environment, Property and Speed[36]. For the prioritisation, the values of severity and frequency were multiplied and those which exceeded a value of 15 were considered as hazard hotspots. If no risk calculation exceeded 15, the highest two values were defined as hazard hotspots.

Table 25 summarises the results of the analyses. The scores which were given for the severity and frequency of the scenarios were set by the pilot company. The numbers in bracket were given by the external experts.

Table 25: Hazard Hotspot Analyses at Hebei Veyong Bio-Chemical

Process step	Danger type	Severity	Frequency	Frequency /severity	Max	Hazard Hotspot
Oxidation Process	Health	1 (3)	2 (5)	2 (15)	2 (15)	Yes
	Environment	1	3	3		
	Property	1	1	1		
	Speed	1	1	1		
Restore Process	Health	1	1	1	6 (16)	Yes
	Environment	2 (4)	3 (4)	6 (16)		
	Property	1	2	2		
	Speed	1	3	3		
Salt Processes	Health	1	1	1	1	No
	Environment	1	1	1		
	Property	1	1	1		
	Speed	1	1	1		

At Hebei Veyong Bio-Chemical Co., Ltd., the following risks and actions were elaborated. These are summarised in Table 26.

[35] Avermectins are chemically related agents which exhibit extraordinarily potent anthelmintic activity.
[36] Where "speed" means the expansion speed of an accident.

Table 26: Identified Risk Scenarios and Actions for Risk Reduction at Hebei Veyong Bio-Chemical

Risk scenario	Action for risk reduction	Economic benefit (RMB Yuan)
There is no sign of emergency exit or emergency access	Add signs of emergency exit and access, and emergency lights	
The signboards of equipment are too small; no sufficient light at working places	Enlarge the signboards of equipment, and install efficient lights	
No information regarding impact and prevention of long-time exposure of different chemicals	Add guide book of the human damage by long-time exposure of each chemical, and how to reduce the damage	
When adding chloride phenyl phosphate ester II too fast, it will react with dimethylsulfoxide, and can cause material spraying	Installation to limit addition of chloride phenyl phosphate ester II	50,000
Reactor may cause material-spraying when the supply of power or frozen brine stops	**Reactor** 1. Add power failure alarm for the stirring 2. Add saline alarm 3. Add explosion venting port	50,000
If the bottom of the extraction tank is broken, the materials will suddenly flow into the extraction, and cause overheating or spray	**Extraction tank** 1. Add explosion Venting port 2. Temperature monitor	52,000
Dissolution tank overheating, material-spraying, or leakage	**Dissolution tank** 1. Add explosion Venting port 2. Use hot water for heating 3. Add temperature alarm for the hot water can	52,000
Reactor overheating, material-spraying	**Reactor** 1. Add explosion Venting port 2. Use hot water for heating 3. Add temperature alarm for the hot water can	54,000
Reactor may cause material-spraying when adding sodium borohydride too quickly	**Reactor** 1. Add explosion Venting port 2. Add power failure alarm for stirring	58,000
Extraction tank overheating caused by adding acids too fast	**Extraction tank** 1. Add temperature monitoring 2. Add current-limiting measures for the adding of acids 3. Add explosion Venting port 4. Keep negative micro-pressure when adding acids	60,000
Dissolution tank overheating, material-spraying	**Dissolution tank** 1. Add explosion Venting port 2. Use hot water for heating 3. Add temperature alarm for the hot water can	60,000
		TOTAL 436,000

The company judged that the environmental benefits are hard to quantify. However, according to their judgement, all of the actions have a positive impact on risk reduction as they have the potential to reduce possible leakage and spillages of chemicals which can lead to explosions, with corresponding effects on health, safety and the environment.

The managers considered that the CD containing the entire RP Handbook was very useful and confirmed their interest in learning more from the CD by themselves. The RP methodology, the introduction, and the training improved the awareness of the managers and staff members with respect to environmental protection and chemical hazard control. This also improved their daily operation related to chemical hazard management.

Obstacles at Hebei Veyong Bio-Chemical

The company is close to the centre of Shijiazhuang City. According to the new city plan, the whole company will be moved out of the centre. As a result, not all identified actions have been implemented, especially those actions involving costly reconstruction of the old buildings. However, the management was committed to considering the identified measures in the design process for the new plant.

The company was already aware of the potential dangers of their production. However, the employees tended to underestimate the severity and frequency of the risk scenarios provided in Table 27. The project team, however, provided more realistic risk scenario scores, according to the CNCPC's team's judgement.

Lessons learned at Hebei Veyong Bio-Chemical

Hebei Veyong Bio-chemical had already completed cleaner production assessments in the past and the company had a high level of awareness of environmental protection and cleaner production. However, Responsible Production provided various tools to help the company to improve their safety management and hence to complement cleaner production.

The project team was able to help company employees gain a better understanding of the nature and level of the risks of the production processes, as identified by the risk scenarios.

The involvement of experts during the project, such as Professor Zhao Jingsong from Tsinghua University as a process-control expert, improved communication between the company and the RP team and provided valuable professional information on process safety management as well as suggestions and comments related to the application of RP.

The advanced RP tool on HAZOP analysis was applied during the pilot project due to the positive commitment by the top management and the technical level of the company. This exercise, although not a full HAZOP study, attempted to analyse all the risks scenarios along the production process.

CHINA

SUMMARY OF LESSONS LEARNED

Both Chinese pilot companies experienced that having top management commitment helped in applying risk reduction actions effectively.

The companies considered RP as a complement to the Cleaner Production (CP) audits that they were used to. Many companies in China are familiar with the principles of CP; this has the potential to help with the uptake of RP more widely.

The project showed that the employees' good level of understanding of chemical hazards and risks allows for the possibility of applying the advanced tools of the Responsible Production Toolkit. Whereas both companies had a level of competency regarding chemical hazards of their operations and understood the risks, one company tended to underestimate the severity and frequency of the accident scenarios. The project therefore showed that external technical support for the assessment of risks is beneficial in order to avoid underestimation of risks.

The companies recognised that reducing the number and severity of hotspots would help them maintain a good image.

This project also highlighted that UNEP's future efforts should focus specifically on the stakeholder engagement and corporate social responsibility (CSR) aspects of the RP approach.

EL SALVADOR

The value of Responsible Production approach to the Salvadorian NCPC is its capacity to create strong awareness in companies for a better chemical handling.

Yolanda Salazar de Tobar
Director, Centro Nacional de Producción Más Limpia El Salvador

Activities and Achievements

In El Salvador, the Responsible Production initiative was integrated in a comprehensive programme of the Salvadorian National Cleaner Production Centre "Centro Nacional de Producción Más Limpia de El Salvador" (CNPML), that additionally covered Resource Efficiency improvement. Staff members of the CNPML and students of "Universidad Nacional de El Salvador" were trained in Resource Efficient and Responsible Production methodologies in order to support companies in undertaking an efficient and professional assessment of chemical hazards associated with industrial processes.

Two companies were eventually selected for the pilot studies: Lácteos La Isla and Martinez and Saprissa.

Following the systematic identification and evaluation of potential hazards in accordance with the RP Toolkit, immediate risk reduction measures were implemented by both companies. However, given the combined implementation of RP and RECP, the companies tended to focus more on energy efficiency issues, which they were more familiar with. In addition, both companies favoured implementing measures leading to short term benefits over the ones that were considered beneficial in the long run.

The RP initiative in El Salvador included the activities summarised in Text Box 9.

TEXT BOX 9

Overview of RP Implementation Activities in El Salvador

1: **Responsible Production workshop**
2: **Selection of companies for pilot projects**
3: **Site visits**
4: **Meetings for presentation of results**

Activity 1 - Responsible Production workshop

A capacity building workshop was organised by the CNPML for their staff and chemical engineering students from the Salvadorian National University (Universidad Nacional de El Salvador). The workshop covered the RP methodology and issues related to Resource Efficiency. The participants were involved in the company selection and the corresponding analyses.

Activity 2 - Selection of companies for pilot projects

A committee was set up to select companies for pilot projects. The committee used the following criteria for selecting companies:

- Company size, as the tools have been developed for SMEs;
- Environmental impact caused by the production activity;
- Amount of chemicals used (no pure engineering/mechanical companies);
- The need for chemical hazard management (insufficient awareness and risk management systems); and
- The presence of both production lines and storage facilities.

Two companies were selected: a small dairy company "Lácteos La Isla", and a medium sized textile company "Martinez and Saprissa".

Activity 3 - Site visits

On-site visits were carried out in June - July, 2010. The visits started with a brief introduction on Resource Efficiency and Responsible Production, providing an overview of the objectives and principles of RP and corresponding tools.

In both companies, caustic soda was considered the only potentially hazardous substance. The RP pilot project activities focused on the processes and areas where caustic soda is used, *i.e.*, the cleaning process and the transportation and storage of caustic soda. The analyses, supported by the CNPML and the Salvadorian National University, included an evaluation of hazard hotspots and risk scenarios as well as references to the applicable legal requirements, consideration of risk-prone and vulnerable groups in case of an accident, and an identification of key stakeholders and their importance (including suppliers and transporters of caustic soda and company workers). Disposal and treatment of the solid waste and waste water were not included in the analyses.

The on-site visits were designed to identify risks related to chemical accidents and to elaborate risk reduction measures, thus enhancing the overall business performance. These analyses were performed on the basis of process flow charts, following the flow of chemicals along the steps of the production processes, and including storage areas. The outcomes of the on-site visits were documented in a systematic way.

At the end of the projects, the companies were provided with tables outlining "Objectives, goals, actions and indicators", detailed chemical control action plans for caustic soda, and training plans for specific audiences including drivers, transport company owners, and targeted groups of employees.

Activity 4 - Meetings for presentation of results

The CNPML met with each of the two companies to present the results of the projects, outlining the identified risks scenarios and corresponding reduction measures. The meetings aimed to raise awareness regarding risks that may arise as a consequence of inadequate chemical management, and to further underline the importance of taking immediate action.

Company Case Study: Lácteos La Isla

Lácteos La Isla is a small company with 15 employees, located at Sonsonate, El Salvador. The company mainly produces dairy by-products for the surrounding communities, and bottles soft drinks and drinking water.

RP pilot project: Situation before versus situation after implementation

The RP pilot project activities focused on the processes and areas where caustic soda is used: the cleaning process and the transportation and storage of caustic soda. Following the brief introductory training, the subsequent on-site visits led to the identification of three hazard hotspots, corresponding risk scenarios for potential accidents, and a number of risk reduction measures (see Table 27). Typical risks included spills and leakages.

Table 27: Analyses of Possible Risk Scenarios at Lácteos La Isla

Hotspot	Risk Scenario	Consequence	Frequency/ Severity	Vulnerable groups in case of an accident
Caustic Soda Transport	Spill	Caustic soda is very corrosive and may affect drivers' skin if they try to stop it. It may damage the truck. Drivers may also breathe caustic soda powder, suffering severe damage to their respiratory system.	3/3	Drivers, Transport company, transport (truck), dairy plant
Caustic Soda Storage	Spill	Caustic soda is very corrosive and may affect employees' skin if they try to stop it. It may damage the storage facilities. Workers may inhale caustic soda powder, suffering severe damage to their respiratory system.	2/4	Dairy plant and its employees, storage facilities
Cleaning	Spill and leakage	Workers may inhale caustic soda powder and suffer severe damages in their respiratory system. Caustic soda solution could leak which is as corrosive as the solid. The leaks may cause serious problems to workers' health, like skin burning. It may enter sewers and affect close water bodies. If not controlled, it may enter drinking water systems and affect neighbours. The leak could affect neighbour's health and property.	3/3	Facilities of the Dairy Plant and its employees, near-by water bodies, neighbours

The consideration of the risk scenarios eventually led to the development of a detailed series of risk reduction measures. In this regard, the provision of appropriate PPE was considered of particular importance (see Table 28).

Table 28: Identified Risk Reduction Measures at Lácteos La Isla

Identified Risk Reduction Measures	
Area 1 Caustic soda transport (Risk of spillage)	
Personnel	Wear appropriate clothing, gloves and boots
	Wear approved dust masks
	Wear chemical goggles
	Do not eat, smoke or talk by cell phone
	Get a first aid kit
	Train drivers in knowledge of handling caustic soda and provide emergency training
Transport	Keep containers dry
	Keep caustic soda away from incompatibles
	Do not transport chemicals with food or any other human or animal consumption product
	Get fire extinguisher
Area 2 Caustic soda storage (Risk of spillage)	
Personnel	Wear appropriate clothing, gloves and boots during caustic soda storage
	Wear approved dust masks during caustic soda storage
	Do not use contact lenses during caustic soda storage
	Wear chemical goggles or full face shield during caustic soda storage
	Do not eat, smoke or talk by cell phone at caustic soda storage
	Get a first aid kit at caustic soda storage
	Train workers to handle caustic soda and provide emergency training
Storage	Keep storage area clean and organised
	Do not block halls, stairs and emergency exits
	Mark well emergency routes
	Identify well the storage area, restrict access of unauthorised persons
	Keep containers tight in storage area
	Keep containers in a cool, well-ventilated area
	Containers in storage area must be opaque
	Eliminate heat and fire sources in storage area
	Check regularly containers for damage during storage
	Label containers
	Do not smoke in storage area
	Keep caustic soda away from incompatibles materials
	No food or any other human or animal consumption product in storage area
	Install fire extinguisher in storage area
	Have a dilute solution of acetic acid close by to neutralise the caustic soda and its corrosive effect

Identified Risk Reduction Measures	
Area 3 Caustic soda cleaning area (Risk of spills and leaks)	
Personnel	Wear appropriate clothing, gloves and boots
	Wear approved dust masks
	Do not use contact lenses
	Wear chemical goggles or full face shield
	Do not eat, smoke or talk by cell phone
	Get a first aid kit for the cleaning area
	Train workers to handle caustic soda and provide emergency training
Handling	Keep cleaning area clean and organised
	Do not block halls, stairs and emergency exits in cleaning area
	Mark well emergency routes
	Use the necessary amount of caustic soda for cleaning
	Eliminate heat and fire sources in cleaning area
	Install fire extinguisher for cleaning area
	Have a dilute solution of acetic acid close by to neutralise the caustic soda and its corrosive effect

Having identified the risk scenarios and developed proper preventive measures, further steps towards an improved chemicals safety management approach were listed. This included setting goals, objectives, targets and performance indicators, as well as the development and implementation of a chemical control plan, training plan and an emergency plan.

Obstacles at Lácteos La Isla

The company participated simultaneously in a pilot project focusing on Resource Efficiency, and tended to focus more on the energy efficiency issues than on risk reduction measures. Moreover, measures leading to short term benefits were clearly favoured over the ones that were considered beneficial in the long run. In addition, the management was reluctant to engage external stakeholders in the RP process, fearing dissemination of internal business know-how (legal matters and production processes). This is considered to be a very common obstacle in El Salvador.

Lessons Learnt at Lácteos La Isla

The benefits of RP were not obvious to the pilot companies in El Salvador, including Lácteos La Isla. The companies were not convinced that the identified risk reduction measures would be necessary or could lead to the desired improvements. The cultures of both pilot companies tended to disregard implementing measures that show benefits only in the long term.

Company Case Study: Martinez and Saprissa

Martinez and Saprissa is a medium sized textile company, employing 57 workers in the production process and 23 in administration. It is located in San Salvador and manufactures canvas and tarps for industrial and home use.

RP pilot project: Situation before versus situation after implementation

In Martinez and Saprissa textile production, the analysis was limited to the use of caustic soda, which involved the scouring process, and the storage and transport of caustic soda. The transport and storage of the textile products, the disposal and treatment of the solid waste and waste water were not included.

Following a brief introductory training, the subsequent on-site visits led to the identification of three hazard hotspots and corresponding risk scenarios for potential accidents (see Table 29). Typical risks included spills and leakages.

Table 29: Analyses of Possible Risk Scenarios at Martinez and Saprissa

Hotspot	Risk Scenario	Consequence	Frequency /Severity	Vulnerable groups
Caustic Soda Transport	Spill	Corrosive: may affect drivers' skin and damage the truck. Drivers may also breathe caustic soda powder, suffering severe damages in their respiratory system.	3/3	Drivers, Transport company, transport (truck), textile company
Caustic Soda Storage	Spill	Corrosive: may affect employees' skin if they try to stop it and damage the storage facilities. Workers may inhale caustic soda powder, suffering severe damages in their respiratory system.	2/4	Textile Company and its employees, storage facilities
Scouring	Spill and leakage	Corrosive: may affect employees' skin if they try to stop it and may damage the scouring area. Workers may inhale caustic soda powder and suffer severe damages in their respiratory system. Leaks may cause serious problems in workers' health like skin burning. Could enter into sewers with effects on close water bodies, which may, if not controlled, affect drinking water and neighbours. A leak could affect neighbours' health and their property.	3/4	Textile Company facilities and its employees, nearby water bodies, neighbours

Thorough consideration of the risk scenarios led to the development of a series of risk reduction measures, many of which are related to the provision of appropriate personal protection equipment (Table 30).

Table 30: Identified Risk Reduction Measures and Implementation at Martinez and Saprissa

Identified Risk Reduction Measures	
Area 1 Caustic soda transport (Risk of spillage)	
Personnel	Wear appropriate clothing, gloves and boots
	Wear approved dust masks
	Wear chemical goggles
	Do not eat, smoke or talk by cell phone
	Provide a first aid kit
	Train drivers to handle caustic soda and provide emergency training.
Transport	Keep containers dry
	Keep caustic soda away from incompatibles, such as oxidising agents, reducing agents, alkalis, metals, acids and moisture.
	Do not transport chemicals with food or any other human or animal consumption product
	Install fire extinguisher
Area 2 Caustic soda storage (Risk of spillage)	
Personnel	Wear appropriate clothing, gloves and boots
	Wear approved dust masks
	Do not use contact lenses
	Wear chemical goggles or full face shield
	Do not eat, smoke or talk by cell phone
	Provide a first aid kit during caustic soda storage
	Train workers to handle caustic soda and provide emergency training
Storage	Keep storage area clean and organised
	Do not block halls, stairs and emergency exits in storage area
	Mark well emergency routes in storage area
	Identify well the storage area, restrict access of unauthorised persons
	Keep containers tight
	Keep containers in a cool, well-ventilated area
	Containers in storage area must be opaque
	Eliminate heat and fire sources in storage area
	Check regularly containers for damage during storage
	Label containers
	Do not smoke in storage area
	Keep caustic soda away from incompatibles materials such as oxidising agents, reducing agents, alkalis, metals, acids and moisture
	No food or any other human or animal consumption product in storage area
	Install fire extinguisher in storage area
	Have a dilute solution of acetic acid close by to neutralise the caustic soda and its corrosive effect

Identified Risk Reduction Measures	
Area 3 Caustic soda scouring (Risk of spillage and leaks)	
Personnel	Wear appropriate clothing, gloves and boots
	Wear approved dust masks
	Do not use contact lenses
	Wear chemical goggles or full face shield
	Do not eat, smoke or talk by cell phone
	Provide a first aid kit for the cleaning area
	Train workers to handle caustic soda and provide emergency training
Handling	Keep cleaning area clean and organised
	Do not block halls, stairs and emergency exits
	Mark well emergency routes
	Use the necessary amount of caustic soda
	Check the scouring pool for leak or damage
	Eliminate heat and fire sources
	Install fire extinguisher for cleaning area
	Have a dilute solution of acetic acid close by to neutralise the caustic soda and its corrosive effect

Having identified the risk scenarios and developed proper preventive measures, further steps towards an improved chemicals safety management approach were listed. This included setting goals, objectives, targets and performance indicators, as well as the development and implementation of a chemical control plan, training plan and an emergency plan.

Obstacles at Martinez and Saprissa

The obstacles were similar to those of the company Lácteos La Isla. Please refer to the previous case study.

Lessons learned at Martinez and Saprissa

The lessons learned were similar to those of the company Lácteos La Isla. Please refer to the previous case study.

EL SALVADOR
SUMMARY OF LESSONS LEARNED

In El Salvador, RP was implemented alongside a Resource Efficiency improvement project. Compared to resource efficiency improvements, the (economic) benefits of RP were more challenging for companies to envisage. As a result, both of the El Salvadorian pilot companies preferred implementing measures that lead to benefits in a short time frame.

During the project, several opportunities for overcoming these concerns were considered: preparing a cost-benefit analysis involving economic impacts due to chemical accidents; raising awareness on the social and environmental impacts of accidents; repeating the risk analyses while taking planned risk reduction measures into consideration; and, if all else fails, reviewing the suggested risk reduction measures. All in all, the conclusions show that future efforts should focus on "marketing" the benefits of risk reduction measures.

Both pilot companies chose to implement the step-by-step RP process, focusing however only on one chemical (caustic soda). Whereas the process that the companies undertook was rather comprehensive (including stakeholder analysis, defining objectives, goals, training plans and emergency plans), future RP efforts should encourage addressing a broader list of hazardous chemicals, given that it is often the combination of different chemicals that poses large risks both on-site and off-site.

Although both companies addressed stakeholders while performing risk assessments, they had no interest of further engaging with external stakeholders due to fears of disseminating confidential company information.

INDIA

Gujarat is one of India's fastest growing states with a multitude of SMEs mainly in the petrochemical, chemical and pharmaceutical industry sectors. This growth has resulted in job creation and increased welfare for the population; however, lacking awareness of chemical hazards and poor control of chemical risks have led to chemical accidents, in particular in SMEs.

The Responsible Production initiative was applied to Indian industries handling chemicals by the Asia Society for Social Improvement and Sustainable Transformation (ASSIST), working in collaboration with the Gujarat Cleaner Production Centre (GCPC), the German based company Beratung für integrierte Problemlösungen (BiPRO) and Underwriters Laboratories Management Systems Solutions India Pvt. Ltd. (UL MSS). The Pilot project was jointly funded by the German investment and development company (Deutsche Investitions- und Entwicklungsgesellschaft GmbH, DEG) and UL MSS. Around 400 company representatives were informed about RP during a series of awareness-raising events that took place in the Gujarat region, which was followed by nine pilot projects.

Altogether 64 company representatives were trained on RP tools and techniques to become local experts. These activities were complemented by the distribution of around 500 "Responsible Production - Learner's and Trainer's Companion" toolkits among industry members.

Participating companies valued the recommended risk reduction measures and either implemented them or indicated that they planned to do so in the near future.

> ***SMEs in Gujarat find the RP Framework as a simple, structured and pragmatic approach. Several industry associations clearly see the needs for RP and have willingly associated with ASSIST to propagate the RP concepts. SMEs who have implemented RP have shared experiences on how even small changes in the way they handle chemicals has made their work place a much safer environment.***
>
> **Sreeni Narayanan**
> **Managing Director**
> **ASSIST**

As some actions needed proper planning and a bigger financial investment, a realistic timetable was set up to accomplish these tasks.

The Responsible Production initiative in India included the following activities, summarised in Text Box 11.

TEXT BOX 11

Overview of RP Implementation Activities in India

1: **Selection of companies for pilot projects**
2: **Training of trainers (T-o-T) workshops**
   - **Workshops**
   - **On-site visits with international experts**
   - **Revision and presentation of the site visit**
3: **Follow-up activities**
4: **Multiplication activities**

Activity 1 - Selection of companies for pilot projects

Altogether nine companies were chosen to participate in the pilot project. Companies were chosen to participate based on the fact that they use some amount of hazardous chemicals in their production and are representative of Gujarati industry sectors, in order to facilitate future multiplication potential. To influence the creation of a market demand for Responsible Production, two rather large companies were selected to participate in the project as role models with the aim of creating a higher impact.

Activity 2 - Training of Trainers (T-o-T) Workshops

The "Secure Gujarat" project included two sets of three-day T-o-T workshops, which consisted of an introductory training session, on-site visits with international experts, and a debriefing presentation and workshop. The 64 professionals, representing various stakeholder groups, were trained on the RP tools and techniques.

First Training of Trainers Workshop

The 3-day event aimed at training a group of approximately 30 stakeholders (representatives from the Gujarat National Cleaner Production Centre (GNCPC), private companies, local fire brigades, academic institutions and state authorities) on the basics of Responsible Production.

The first day, the introductory training workshop, was conducted by international experts (BiPRO) and focused on selected analytical tools and best practices related to RP. The participants also developed skills in applying selected RP methods during site visits to three different companies (see sections 4.6.2 to 4.6.4).

The second day was dedicated to the practical on-site implementation of RP. The audience was divided into three groups, each visiting one of the selected companies. Each team included an international expert and the Chief Executive Officer (CEO) of the corresponding pilot company. The site visits focused on applying the following tools from the RP Toolkit: Tool 1.1 (Prepare process flow chart), Tool 1.2 (Chemical inventory and hazard classification), Tool 1.3 (Identify health, social, environmental and economic risks), Tool 1.4 (Hazard hotspot map), and Tool 3.1 (Identify actions for risk reduction).

At the beginning of the site visit, a table (see Table 31) was presented and explained to the team.

Table 31: Assessment Table for Site Visits in India

Process steps / Storage area	Chemicals	Hazard / Risk	Frequency/ Severity[28]	Priority	Risk reduction measure

[28] The assessment of the severity of the impacts in an accident situation and the likelihood of the identified accident situations taking place is based on tool 1.3 of the Responsible Production Toolkit. Scales of 1-5 are used for both parameters, where a severity of 1 refers to negligible and 5 catastrophic and frequency of 1 refers to practically impossible and 5 to frequent. Refer to pages 20-21 of Responsible Production Toolkit.

The first four columns of the table were filled in during the on-site visit, mainly supported by the CEO and other employees of the pilot company, providing them with an understanding of the company's performance and a means for identifying the hazard hotspots as team work. The teams followed the chemical flow through the process steps from the raw material storage through all production steps until the end product. At critical locations, team members were given instructions on the hazards and risks associated with specific substances. On the basis of these activities, the teams elaborated possible accident scenarios, along with their frequency and severity and corresponding risk reduction measures, followed by a prioritisation of the risks (RP Tool 1.3).

The third day of the T-o-T workshop was dedicated to summarising the companies' findings in a structured and easy-to-apply way. Each of the three groups shared the results of the company visits with all participants. The international experts summarised the findings in short company reports, which were intended to serve as guidelines for follow-up and further implementation.

The concluding discussion stressed that the company visits serve as first starting points to put the concept of RP into practice but that only continuously increased awareness and implementation make a real difference. Also emphasised was the need for preparing a reliable decision basis, with a corresponding costs and benefits analysis, for the management to appropriately select risk reduction measures.

Second Training of Trainers Workshop

In order to further disseminate UNEP's Responsible Production approach, the Gujarat Cleaner Production Centre and ULMSS conducted a second two-day workshop with a group of 24 stakeholders.

Day 1 consisted of an introductory training on the facts and figures of the RP approach. Selected analytic tools and international best practices were presented to the participants to help them in the implementation of RP at their companies. The learning experience was reinforced by demonstration videos and practical examples from international case studies.

Day 2 focused on on-site visits at two companies to demonstrate the practical implementation of the RP framework. The walk-through started with a discussion on the basic information on the companies' chemical processes, followed by the identification of potential risks and corresponding risk reduction measures. The afternoon of the second day was used by participants to summarise all findings and create short company reports.

Activity 3 - Follow-up activities

Following the on-site visits, GCPC, ASSIST and UL MSS continued supporting the companies in implementing risk reduction measures. Detailed summary reports for each company and the subsequent implementation of the risk reduction measures, as well as related cost-benefit analyses, were prepared. With the completion of all gap assessments, follow-up visits were performed to monitor the developments. Further details on implementation may be found in sections 4.6.2, 4.6.3, and 4.6.4.

Activity 4 - Multiplication activities

- **CEO Forums**: As a main multiplication activity, ten CEO Forums were organised in various locations in Gujarat to sensitise CEOs and top management representatives from companies that produce, use or handle chemicals on the need and benefits of Responsible Production. This initiative has attracted around 400 company delegates who all showed keen interest in implementing the RP framework in their respective organisations. These CEO Forums have

been organised in close collaboration with industry associations (Indian Chemical Council (ICC), Confederation of Indian Industries (CII), VAPI Industry Association (VIA), Gandhi Dham Industry Association and Ankaleshwar Industry Association) and government representatives to create a widespread impact in the region.

Encouraged by the good reception RP framework had in Gujarat, the project team also organised two CEO forums outside the state of Gujarat, in city of Chennai and the territory of Pondicherry. This was done in close collaboration with Madras Chambers of Commerce and Industry (MCCI). The forums were attended by over 115 participants. ASSIST along with MCCI is exploring options of organising follow up programs for interested companies in the region.

The direct implementation support ended in November 2011 and the lessons learned were shared among the implementing companies and with key stakeholders through best practice exchange forums.

- **Training Materials**: UNEP and ASSIST developed "Responsible Production Learner's and Trainer's Companion", including all relevant information on Responsible Production, and disseminated it to company representatives during various events. The launch of the toolkit took place during one of the CEO Forums.

Company Case Study: Industrial Chemical Works

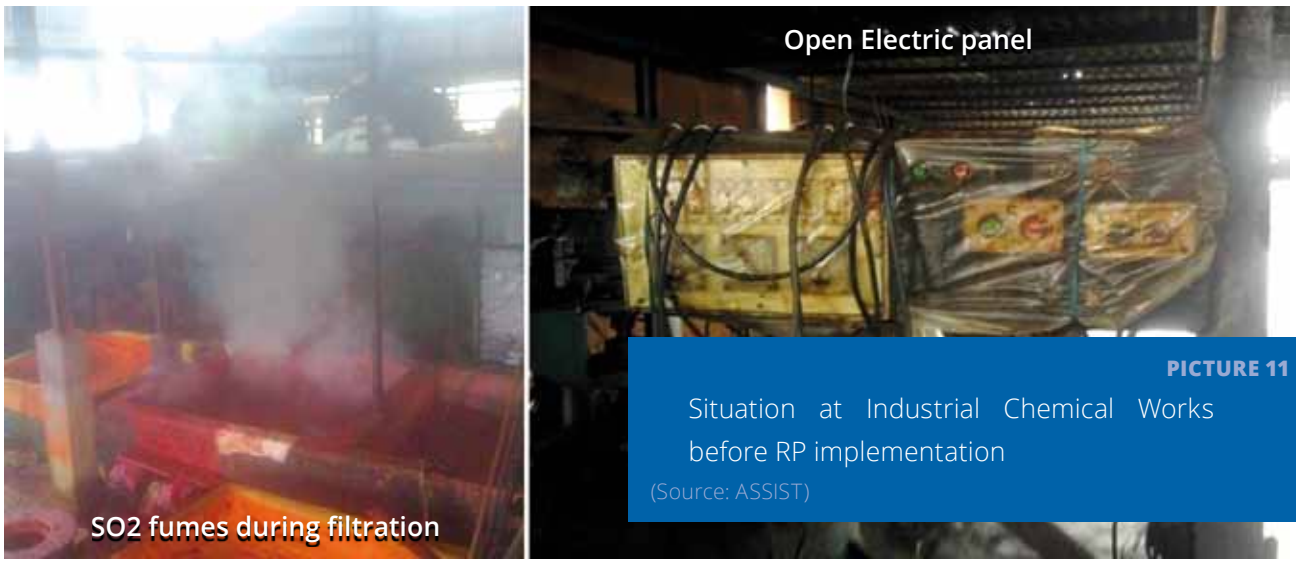
Founded in 1987, Industrial Chemical Works is the largest manufacturer and exporter of PAAB4SA (Para Amino Azo Benzene 4 Sulfonic Acid). Industrial Chemical Works has been incorporated into the Prashant Group that specialises in the manufacturing of dye, pigment, pharmaceutical and cosmetics intermediates and other special intermediates at three different production plants.

RP pilot project: Situation before versus situation after implementation

The on-site visit led to the identification of seven hazard hotspots and corresponding risk scenarios related to the process steps (summarised in Table 32).

Table 32: Analyses of Possible Risk Scenarios at Industrial Chemical Works

Process steps / Storage area	Chemicals	Risk	Frequency / Severity
AMSE, nitration	Aniline	Overflow of receiver tank	2/3
AMSE	Formaldehyde	Overflow of receiver tank	2/4
Sulfonation	Oleum	Spillage, overflow	2/5
Storage tank 40 t/month	Aniline	Spillage, overflow	2/5
Storage tank 20 t/month	Formaldehyde	Spillage, overflow	2/5
Storage tank max. 12 t	Oleum	Spillage, overflow	2/5
Storage tank max. 12 t	Oleum	Continuous SO_3 emissions	5/3 (priority)



PICTURE 11

Situation at Industrial Chemical Works before RP implementation

(Source: ASSIST)

By thoroughly considering the risk scenarios, the company was able to develop a corresponding series of risk reduction measures, which were prioritised by looking at the risk scenarios. As a result of the RP activities, a number of the measures were implemented, thereby greatly improving the control of chemical risks (see Table 33).

Table 33: Identified Risk Reduction Measures and Implementation at Industrial Chemical Works

Identified Risk Reduction Measures
Inspect storage tanks regularly
Install pipes to inhibit overflow of receiver tank
Improve secondary containments for storage tanks
Install secondary containment of formaldehyde separated from others
Seal oleum tank properly
Apply a daily routine of water level of the SO_3 scrubber tank

Obstacles at Industrial Chemical Works

Convincing workers to use PPEs was found to be one of the major obstacles at Industrial Chemical Works as it was generally considered to slow down work performance and to be unpleasant particularly during the summertime heat. In addition, some of the PPE being used at Industrial Chemical Works do not meet appropriate quality standards, which further discourage workers from the use of the equipment. However, the management has agreed to address this issue in the near future.

Lessons learned from the pilot project at Industrial Chemical Works

Although the company was ready to implement many of the technical risk reduction measures involving installing equipment, company safety culture hindered efficient use of PPE. The staff would benefit from training activities focusing on the benefits of the use of PPE.

Company Case Study: J. B. Industry

J.B. Industries was established in 1987 and specialises in the production of dye intermediates and optical brightening agents. The main products include P-nitrotolune-0-sulphonic acid (PNTOSA), 4,4 Diaminostilben, 2,2 Di sulphonic acid (DASDA) and 4,4 Dinitrostilbene 2,2 Di sulphonic acid (DNSDA).

RP pilot project: Situation before versus situation after implementation

The on-site visit led to the identification of six hazard hotspots and accident scenarios located at various process steps (summarised in Table 34). Thorough consideration of the risk scenarios allowed the company to develop a corresponding series of risk reduction measures and to prioritise them.

Table 34: Analyses of Possible Risk Scenarios at J.B. Industry

Process steps / Storage area	Chemicals	Hazard / Risk	Frequency / Severity
Chlorination	Chlorine	Spontaneous and rapid leakage of up to 900 kg Cl_2	3/5 (priority)
Sulfonation	Oleum	Leakage, spillage	4/2
Sulfonation	Para-nitrotoluene	Fire, explosion	1/4
Oxidation	Hypochlorite	Corrosion	2/3
Storage tank 14,550 kg	Oleum	Malfunction of tank	1/4
Storage tank 10,000 L/day	Hypochlorite	Corrosion	2/3

As a result of the RP activities, various measures were implemented, thereby greatly improving the control of chemical risks in this company (see Table 35).

Table 35: Identified Risk Reduction Measures at J.B. Industry

Identified Risk Reduction Measures
Ensure that appropriate gas mask is in place at chlorine tank
Provide emergency training of workers for chlorine tank leakage
Install an atomised spray sprinkler system at chlorine tank
Neutralise material in place at chlorine tank
Install secondary containment for oleum tank
Organise regular inspection of oleum tank
Provide neutralisation material in place at oleum tank
Ensure availability of proper PPE at oleum tank
Provide fire fighting equipment against fire and explosion of para-nitrotoluene
Raise awareness against fire and explosion of para-nitrotoluene
Organise regular inspection of hypochlorite containing pipes and vessels

Only one breathing apparatus near chlorine tank

Storage of PNT drum / container on double deck

PICTURE 12

Situation at J. B. Industry before RP Implementation

(Source: ASSIST)

Obstacles at J.B. Industry

Limited financial resources hindered the company from implementing some of the more cost-intensive measures, *e.g.*, the installation of a water hydrant/sprinkler system. In addition, convincing workers to use PPEs was found to be one of the major obstacles as it was generally considered to slow down work performance and to be unpleasant particularly at high temperatures.

Lessons learned from the pilot project at J.B. Industry

Whereas company J.B. Industry was very receptive to the idea of RP, regular and systematic awareness-raising activities and training targeted at specific audiences are necessary for rooting RP thinking deeper into the company's safety culture.

Company case study: Shree Organo Chemicals

The company Shree Organo Chemicals was established in 1994 and focuses on the production of dye intermediates. The main products include 4-aminodiphenylamine-2-sulphonic acid and Amino G acid.

RP pilot project: Situation before versus situation after implementation

The on-site visit at Shree Organo Chemicals served to identify risk scenarios corresponding to the relevant process steps and their related hazard hotspots. Following the assessment of the risk scenarios, the company, jointly with the local and international experts, developed a series of risk reduction measures. These findings are summarised in Table 36.

PICTURE 13

Situation at Shree Organo Chemicals before RP implementation

(Source: ASSIST)

Table 36: Identified Risk Scenarios at Shree Organo Chemicals

Process steps / Storage area	Chemicals	Hazard / Risk	Frequency / Severity
Sulfonation	Aniline	Leakage, spills	3/5 (yes)
Liquid storage tanks 10-15 t	Oleum, concentrated acids (sulphuric acid, hydrochloric acid), ammonia	Overflow, leakage, spills	4/2
Pipes/Vessels	Various chemicals	Corrosion, leakage	1/4

As a result of the RP activities, six measures were implemented to improve the control of chemical risks (see Table 37).

Table 37: Risk Reduction Measures at Shree Organo Chemicals

Identified Risk Reduction Measures
Separate storage of different chemical groups
Isolated access control in storage (related to sulfonation process)
Installation of standard operational procedures for filling of storage tanks
Regular inspection of storage tanks
Secondary containment for storage tanks
Regular inspection of pipes

In addition to the compilation of these specific measures, some general safety measures were suggested, including:

- Improved housekeeping measures: a detailed map of the facility, clearing pathways, setting up of clear signs and having regular inspections.
- Improved electrical and fire safety: proper wiring and availability of fire-fighting equipment.
- Personal Protection Equipment: awareness raising training outlining the importance of PPE, and ensuring availability of appropriate PPE where needed. The workers should be well-trained on how to use the equipment and proper usage should be monitored.
- Proper labelling: labelling of chemicals/ containers and tanks, provision of MSDSs and monitoring their use.

Obstacles at Shree Organo Chemicals

Convincing workers to use PPEs was found to be one of the major obstacles as it was generally considered to slow down work performance and to be unpleasant particularly at high temperatures. In addition, some of the PPEs being used do not meet appropriate quality standards, further discouraging workers from the use of PPE. However, the management has agreed to address this issue in the near future.

Lessons Learned from the pilot project at Shree Organo Chemicals

The lessons learned were similar to those of the company J. B. Industry. Please refer to the previous case study.

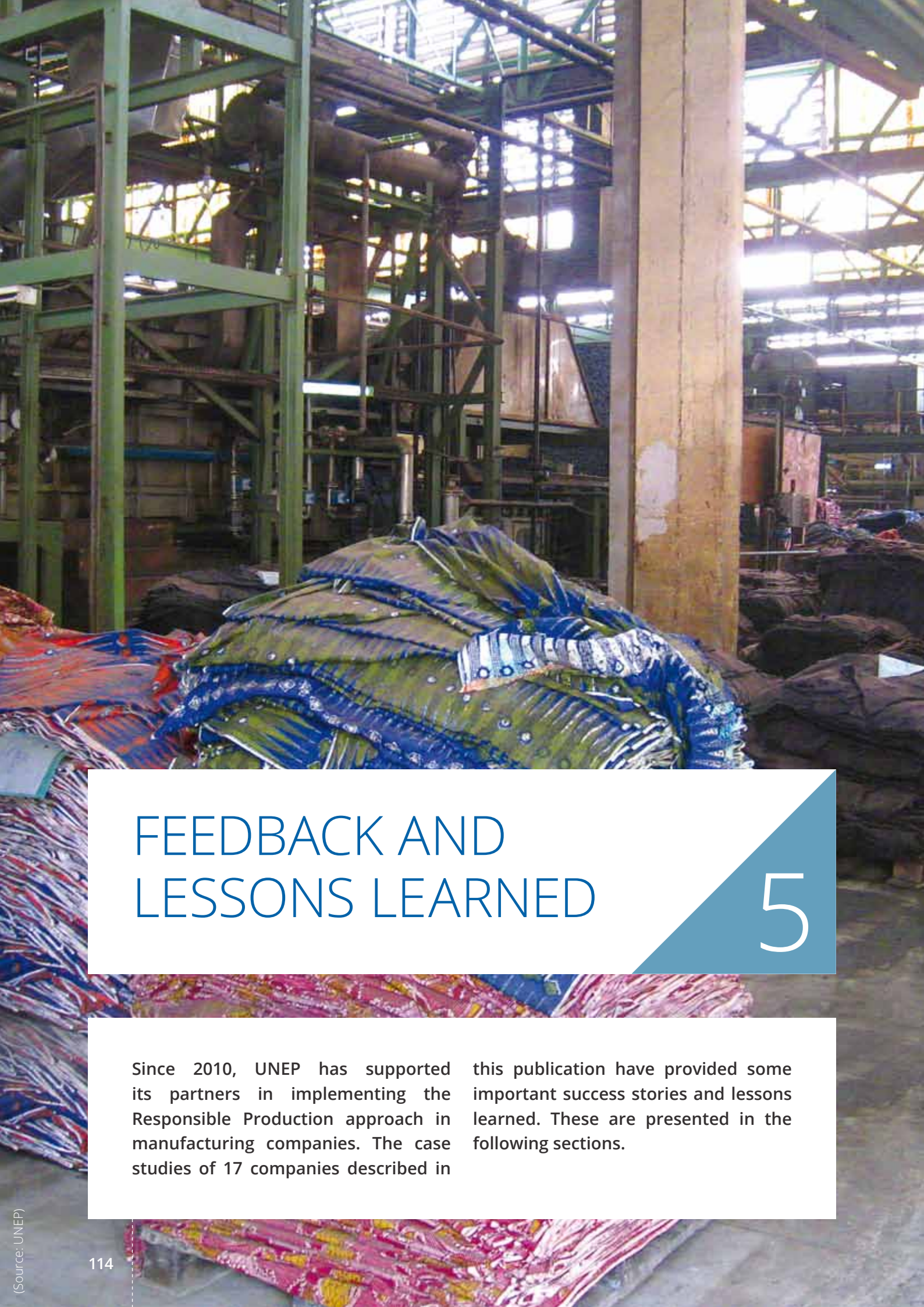
Picture 13 further illustrates the situation at the company before RP implementation.

TEXT BOX 12

INDIA
SUMMARY OF LESSONS LEARNED

The activities that were implemented in Gujarat, India, highlighted the importance of embedding multiplication activities in pilot projects. In this case, multiplication activities consisted of building a local base of experts through Training-of-Trainers workshops and through CEO forums aimed at raising awareness of top management who can drive Responsible Production in their companies' networks.

The company implementation showed an immediate need for addressing risk reduction in one sub-sector (intermediates). Particularly, the use of appropriate PPE was considered an obstacle that would require greater attention in the future. This obstacle was shared among all of the companies.



FEEDBACK AND LESSONS LEARNED

5

Since 2010, UNEP has supported its partners in implementing the Responsible Production approach in manufacturing companies. The case studies of 17 companies described in this publication have provided some important success stories and lessons learned. These are presented in the following sections.

(Source: UNEP)

OVERALL RESPONSE TO THE RESPONSIBLE PRODUCTION APPROACH

Responsible Production was shown to provide an overall generic framework which is flexible to accommodate the specific circumstances and needs of individual SMEs ranging from small family businesses to medium sized companies with hundreds of employees.

The pilot projects showed that companies are generally familiar with Resource Efficiency and Cleaner Production, and introducing RP as part of such initiatives makes sense. There is a need for the experts involved in RP projects to provide a clear explanation in order to avoid misunderstandings relating to the objectives of the RP approach and to have a better understanding of the distinctions and similarities between Cleaner Production and Responsible Production approaches, including complementary aspects, in order to better support companies.

Since the RP Toolkit is an easy-to-apply framework, it was generally very well-received and SMEs were easily convinced to become pilot project partners. In many cases, awareness-raising workshops were reported to be sufficient to motivate companies to kick-start implementation of certain RP elements by themselves.

However, each company is unique and, therefore, Responsible Production activities should be adapted to each company's specific characteristics. Some examples of the type of characteristics that had an impact on implementation included: the extent to which top management was engaged and supported RP implementation; the interest the company saw in engaging external stakeholders; and how costs and benefits of risk reduction measures were calculated and communicated to management and stakeholders.

Overall response to implementation

Going through the entire Responsible Production methodology can be a lengthy process, involving not only on-site activities, but also a constructive dialogue with external stakeholders including those involved in the value chain. However, this experience has shown that starting by focusing on limited parts of the RP methodology can identify opportunities for risk reduction with significant benefits at no or limited costs. Most of the pilot companies focused only on the first steps of the RP methodology and were able to identify effective low or no-cost risk mitigation measures that could be implemented quickly.

In fact, the pilot projects demonstrated that the majority of suggested risk reduction measures could be implemented during the course of the project phase. This applied particularly to those measures that did not require significant financial investments (*i.e.* the "low hanging fruit").

The commitment and support of senior management was regarded as essential for the efficient implementation and acceptance of risk reduction measures. For this reason, it is important to point out that RP visits are neither audits nor inspections, but are meant to support the company in the continuous process of long-lasting performance improvement.

KEYS TO SUCCESSFUL RP IMPLEMENTATION

Defining RP and its relationship to other initiatives

Efforts should be made to ensure that companies understand the purpose and benefits of RP and how it relates to other initiatives such as Cleaner Production and Resource Efficiency, and what potential synergies exist between the various initiatives. In addition, an issue that was raised throughout the pilot projects is the relationship between RP and legal requirements including permits and regulatory mandates.

- This underscores the importance of involving external experts to provide technical support to companies and clearly communicating that RP is a voluntary chemicals management strategy that can help meet and exceed existing regulatory requirements.

Stakeholder involvement

Involving relevant stakeholders in RP activities was noted to be important for the effective implementation of RP. Tools provided in the RP Toolkit were considered helpful for improving relations with stakeholders such as communities and suppliers.

- In particular, the engagement of company employees (especially production workers) has proven very valuable in obtaining sufficient information on potential shortcomings and in contributing to capacity-building efforts, paving the way for successful implementation of risk reduction measures.

- In some cases, companies encountered difficulties in convincing external stakeholders to support the idea of RP. In addition, some participating SMEs were reluctant to engage external stakeholders, such as authorities, fearing that they may have to remedy potential shortcomings or because of concerns about sharing business information.

Capacity-building

The feedback from the pilot projects confirmed that employee training is a prerequisite for applying the Responsible Production approach. The pilot companies recognised the need to train and drill employees in chemical risk management and the safe handling of chemicals.

- In particular, it is important that companies train experts in process safety management as part of a continuous effort for improving chemicals management. In addition to building technical capacity, employees should be made aware of the general ideas and objectives underlying Responsible Production.

- Employees should be trained to pay attention to the potential of accidents to have impacts on the environment, property or community in addition to worker related hazards.

- To be most effective, it was recognised that there is a need to adapt curricula and training modules to the target audience especially given the broad range of industry sectors that should address chemical safety and the different backgrounds of the personnel involved in training activities in terms of education, experience and areas of responsibility.

Trust-building

Trust-building activities between industry and NCPCs (or other external experts) were considered a key to success in many of the pilot projects:

- These experiences demonstrate the importance of creating an atmosphere of mutual trust, clearly defining objectives and responsibilities in the run-up of each project.

On-site visits

The projects included on-site visits by experts to help identify potential hazards and develop a plan on how to address them in an appropriate way. In order to be able to make most effective use of these on-site visits, it is important to prepare well, and collect basic information from the company.

- The experience from the projects revealed that these visits need not involve a long or onerous process. A number of the pilot companies found that a thorough, yet brief, on-site visit was enough to identify "low-hanging fruits", provided that there was careful preparation including collection of information in advance relating to the process description, inventory of chemicals, and the plant layout and premises.

(Source: Christian42, Fotolia.com)

- For some projects, it was shown to be beneficial to limit initial on-site visits and further RP activities to certain company sections due to time constraints and/or the company's size and complexity. In this way, all RP issues of a particular production line or department can be adequately addressed and may serve as *an example* for the subsequent implementation of RP in other areas of the company. In parallel, it is important to emphasise that RP questions should be comprehensively assessed for the entire company, including all production areas and on-site and off-site storage areas.

- Specifically adapted implementation templates contributed to the success of some on-site visits. Such templates can help a company compile inventories or design process flow charts that further simplify the application of RP toolkit, and may make it easier to take local aspects into consideration.

Implementation of Risk Reduction Measures

In most pilot companies the majority of suggested risk reduction measures were implemented in the course of the project phase. This applied particularly to those measures that did not require significant financial investments.

- In developing risk reduction measures, it is helpful for companies to undertake cost-benefit analyses. It is important for companies to understand that risk reduction measures should not be regarded as mere "cost-factors" but, rather, as investments that will benefit the company in the long-run. However, it should be noted that it is often difficult to quantify the economic and environmental benefits of avoiding chemical accidents, and these analyses often require time and resources, therefore, may not always be practical and feasible for a small company to undertake.

- In some cases, companies were hesitant to invest beyond the low-cost measures due to a perceived lack of easily observable benefits in the short term. Several possible ways to overcome this reluctance were identified, such as: i) supporting companies to prepare cost-benefit analyses to compare costs (fixed costs and operating costs) and savings (*e.g.*, from avoided accidents and increased production efficiency); ii) implementing a continued process of risk analysis including planned risk reduction measures over time.

- It may be useful for companies to have external advisors to assist the companies' management[37] in implementing RP measures. Experts can provide insights on best practices from other places in the world. This can provide companies with new perspectives on how to review its routines and put risk reduction measures into practice. Experts often help in developing and analysing realistic risk scenarios and can support efforts to implement measures which the company may not otherwise consider priorities, as well as propose cost-effective measures perhaps unknown to the company.

- SMEs often face the challenge to balance changes in production processes (*e.g.*, due to expanding or restructuring the product portfolio) with the concurrent need to address safety issues properly. In some cases, these circumstances hampered a comprehensive implementation of RP.

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[37] A clear strength of Responsible Production is its easy and flexible applicability which leads to practical improvements at companies of different industry sectors, and in differing country contexts. However, it should be pointed out that even by applying RP, not all accidents can be avoided and therefore those experts and employees involved in RP implementation cannot be held liable.

CONCLUSIONS AND PLANS FOR THE FUTURE

6

(Source: RGtimeline - Fotolia.com)

The activities of UNEP that followed the publication of the Responsible Production Handbook in 2010 supported testing the applicability of RP in different SME contexts around the world and in obtaining feedback and recommendations. The first regional outreach activities and the consequent industrial pilot implementation activities have led to feedback that can be valuable for a broad range of stakeholders, including SMEs, NCPCs, industry associations, national and local authorities, insurance companies, potential donors, international organisations and others. This can pave the way for an expanded adoption of Responsible Production. In particular, the feedback presented in this publication can support the adoption of RP as part of the standard service portfolio of NCPCs, ultimately leading to increased application of RP practices among SMEs. In concluding the projects, UNEP is well positioned to summarise and synthesise the lessons learned and to present recommended plans for the future.

The Responsible Production approach is designed for those companies that do not have sophisticated safety management systems in place, helping the companies to understand the benefits of improved chemical hazard management and how to increase overall safety and reduce chemical emergencies through risk planning, management and communication along the value chain. The feedback showed that Responsible Production was considered flexible enough to be applied to different industry sectors with varying levels of complexity of industrial processes and a range of company sizes[38] in different parts of the world.

As presented in Chapter 2, the **Responsible Production Approach can be promoted as a pillar of sound chemicals management** and should be

[38] The number of employees of the pilot companies ranged from 21 to 3,000. It is worth noting that there are various definitions of what constitutes an "SME" around the world.

applied comprehensively taking into consideration efforts made with related activities, such as Cleaner Production, Resource Efficiency, and Chemical Leasing. The Responsible Production approach can also support companies' efforts to comply with permit requirements and regulations related to risk reduction and accident prevention.

The concept of **Responsible Production foresees stakeholder involvement** throughout the value chain. However, in practice this is challenging to realise. These pilot projects had a specific focus on identifying and prioritising risks in order to determine appropriate risk reduction measures. They provided valuable feedback on the first step of the RP Approach (Identify Responsible Production Issues) and the third and the fourth steps (Planning and Implementing RP Issues). This said, the exercise did not provide sufficient means (time, expertise, experience) for companies to fully engage with stakeholders.

During the first pilot projects, the limited timeframe hindered fully engaging with stakeholders, especially since this can be very time-consuming given that stakeholder considerations will be new to many SMEs. Involving stakeholders little-by-little can present an appropriate solution, starting with the suppliers and neighbours with whom the company staff is likely to have had contact in the past. In addition, engaging with suppliers of technical equipment and machinery may be very valuable, particularly in cases where changes in production are foreseen. Future efforts on RP should aim to further explore and optimise the stakeholder engagement aspects.

UNEP continues to support multi-stakeholder projects on the Responsible Production approach and will seek opportunities to promote a closer collaboration between companies and the relevant stakeholders along the value chain. As part of this effort, UNEP aims to enhance the capacities of national experts to provide technical support to Responsible Production implementation and to encourage additional NCPCs to incorporate Responsible Production in their portfolio of services. In this context, UNEP has recently entered a Memorandum of Understanding (MoU) with the Tsinghua University of China to join forces to undertake research and education on Responsible Production as well as Awareness and Preparedness for Emergencies at the Local Level (APELL) and foresees similar partnerships beneficial in other countries in the world.

UNEP furthermore plans to provide means for national experts to support SMEs in implementing Responsible Production in synergy with other relevant approaches, including RECP, UNIDO's Chemical Leasing, and the Flexible Framework for Addressing Chemical Accident Prevention and Preparedness and APELL, as well as the chemical industry's Responsible Care® Programme and Global Product Strategy. For example, building on the Responsible Production pilot project in Sri Lanka, UNEP has partnered with the NCPC in implementing Responsible Production in synergy with the *Flexible Framework Guidance* and the chemical industry's Responsible Care® programme. Likewise, these experiences have led to the development of a full project combining UNEP's Responsible Production Approach and the chemical industry's strategies (RC, GPS) in the African Region to be implemented in 2013-2014.

RECOMMENDATIONS FOR FUTURE ACTIVITIES

- Replication of pilot applications and further dissemination of the results as success stories.

- Targeted training events in other countries, together with the chemical industry and industry associations as well as with authorities, stressing the synergies and the added value that can be created for SMEs and integrating the stakeholder engagement aspect. Expanding local expertise through the "Train-the-Trainer" principle would also support implementation in practice.

- Dissemination of existing experience and results at national and international events and conferences for sustainable chemistry and sound chemicals management, highlighting the synergies to other pillars of sound chemicals management such as Resource Efficient and Cleaner Production, and Chemical Leasing (Resource Efficiency Improvement).

- Development of web based platforms at the global, regional or national level to bring information on Responsible Production to a wider public and to support the creation of a "Responsible Production Network" among NCPCs that collaborates on know-how and capacities within existing networks (*e.g.*, RECP). This may also be accomplished by using appropriate communication tools for the exchange of experiences. In particular, any effort should clearly summarise and illustrate the achievements of specific companies.

ANNEX

Overview of relevant legal frameworks	
MAJOR ACCIDENT PREVENTION	
INTERNATIONAL	Convention 174 Concerning the Prevention of Major Industrial Accidents (1993) of the International Labour Organisation (ILO) and the Convention on the Transboundary Effects of Industrial Accidents (1992) of the UN Economic Commission for Europe (UNECE) address chemical accidents on a global and regional scale. Whereas the ILO Convention addresses the prevention of accidents and the limitation of consequences of major accidents involving hazardous substances, the UNECE Convention focuses on promoting cooperation between countries before, during and after industrial accidents with the potential for transboundary consequences in UNECE region.
EUROPE	In Europe, a major accident with chemicals occurred in Seveso, Italy, in 1976, which prompted the adoption of legislation aimed at prevention and control of such accidents. The so-called "Seveso" Directive, which was subsequently amended, most recently by "Seveso III" (2012/18/EU), obliges member states of the European Union to fulfil certain requirements, (*e.g.*, risks assessments, safety inspections, emergency preparedness plans, safety management systems, provision of information to the public) on thousands of industrial establishments where dangerous substances are present in quantities exceeding the thresholds listed in the Seveso Directive.
UNITED STATES	The regulatory system is based on the Occupational Health and Safety Act of 1970, and the Clean Air Act Amendments of 1990, and most notably the Risk Management Plan Rule (RMP Rule), which implements the relevant section (Section 112(r)) of the Clean Air Act Amendments. Based on existing industry codes and standards, the RMP Rule obliges companies using flammable and toxic substances to develop a Risk Management Plan, which covers aspects such as hazard assessment, prevention precautions and emergency preparedness, and submit it to the United States Environmental Protection Agency.
OCCUPATIONAL HEALTH AND SAFETY	
INTERNATIONAL	Through the Safework Programme, ILO promotes international labour standards on OSH issues. These legal instruments (either legally binding conventions/treaties or recommendations) drawn up by the ILO's constituents (governments, employers and workers) set out basic principles and rights at work. ILO standards on occupational safety and health provide essential tools for governments, employers, and workers to establish sound prevention, reporting and inspection practices and to provide for maximum safety at work. The ILO has adopted more than 40 standards specifically dealing with occupational safety and health.
EUROPE	In the European Union, the Council Directive 89/391/EEC (1989) on the introduction of measures to encourage improvements in the safety and health of workers at work establishes base rules on protecting health and safety of workers. It lays responsibility on the employer to establish means and measures for protecting workers to avoid and manage risks, give appropriate instructions regarding protective measures, and consider working conditions, equipment and working methods. This Framework Directive is supplemented by the sectoral Directives that, among other issues, deal with Personal Protective Equipment and Manual Handling work.
UNITED STATES	Under the Occupational Safety and Health Act of 1970, the government's role is to assure safe and healthful conditions for working men and women. The US Occupational and Health Administration (OSHA) does so by: enforcing the standards developed under the Act; assisting and encouraging the States in their efforts to assure safe and healthful working conditions; and providing research, information, education, and training in the field of occupational safety and health.

CLASSIFICATION AND LABELLING OF CHEMICALS	
INTERNATIONAL	The United Nations, under the auspices of the Inter-organisation Programme for the Sound Management of Chemicals (IOMC), created the Globally Harmonised System (GHS) with a purpose of harmonising different schemes and to develop a single, globally harmonised system to address classification of chemicals, labels and safety data sheets. GHS includes criteria for the classification of health, physical and environmental hazards, as well as specifying what information should be included on labels of hazardous chemicals as well as safety data sheets. The first edition was published in 2003. Since then, the GHS has been updated, revised and improved every two years as needs arise and experience is gained in its implementation.
EUROPE	Within the European Union, the Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemical substances (REACH- EC 1907/2006) deals with the control of risks that chemicals pose on human health and the environment. At the beginning of 2009, REACH was complemented by the so-called "CLP regulation"(EC 1272/2008), which aligns the classification, labelling and packaging of chemical substances with the UN GHS and sets standards for both the evaluation and communication of a substance or mixture with respect to its hazardous properties. Both REACH and CLP impose greater responsibilities on chemical manufacturers and importers for understanding the potential adverse effects of chemicals and to appropriately manage any risks associated with their use. Moreover, industry needs to provide sufficient information on chemicals and risk management measures to their downstream users (*e.g.*, in the form of SDS). This, in turn, improves the availability of data on chemicals for the greater public[39].
UNITED STATES	The Department of Labor's Occupational Safety and Health Administration (OSHA) has principal responsibility for regulating classification, labelling and material safety datasheets. Since 2009, OSHA has been aligning their Hazard Communication Standard (HCS) with the GHS. Other agencies that deal with classification and labelling in the US include the Department of Transport (transport sector), the Consumer Product Safety Commission (non-pesticide household chemicals) and the Environmental Protection Agency (pesticides). Whereas prior to GHS each of the agencies had its own system of classification criteria and use of symbols, these elements are standardised under GHS, leading to one, single system of classification and hazard communication.

[37] While it is recognised that REACH and CLP are European regulations, their influence outside of Europe is three-fold: (a) product stewardship of chemical manufacturers is enhanced requiring extensive risk assessment and information to be available down the supply chain; (b) the CLP regulation streamlines hazard labelling all around the world (according to GHS); and (c) companies (including SMEs) from outside the EU are obliged to comply with REACH/GHS legislation when they intend to offer their products on the European market. In this sense, the relationship between RP and REACH goes two ways: REACH leads to better data being available on chemicals and RP can help manage chemical data for those companies needing to comply with REACH for export purposes.

TRANSPORT OF HAZARDOUS SUBSTANCES	
INTERNATIONAL	In the international context, there are two major UN regulations that deal with the transport of hazardous substances, structured according to the respective transport medium they address. Concerning road transport, the European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) was set up in 1957 under the auspices of the United Nations Economic Commission for Europe (UNECE) and has been amended various times since then. In short, the ADR lays down the conditions for the goods in question, in particular as regards their packaging and labelling (in Annex A) and the construction, equipment and operation of the vehicle carrying these goods in question (in Annex B). Secondly and in a similar way, the European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) was prepared under joint auspices of UNECE and the Central Commission for the Navigation of the Rhine CCNR and entered into force in 2008. In addition, UN Recommendations on the Transport of Dangerous Goods further complement the above-mentioned legislations. Although not being binding in their nature, it is expected that governments conform to the principles laid down in Model Regulations when revising or developing regulations on a national level. Outside the scope of the UN framework, the Intergovernmental Organisation for International Carriage by Rail with its 45 Member States set up the Regulations concerning the International Carriage of Dangerous Goods by Rail (RID), whose latest amendments entered into force in 2011. The standards laid down in these regulations are further harmonized with the respective non-binding UN Recommendations.
EUROPE	Under European Union law, Directive 2008/68/EC deals with the transport of dangerous goods by road, rail and inland waterway. In terms of content, the directive explicitly refers to agreements reached by international bodies, more precisely to the abovementioned ADR, ADN, and RID, and assures the applicability of these agreements both within and across the borders of EU Member States. In addition, Directive 95/50/EC and Directive 98/91/EC supplement the legislation by laying down standards for checks carried out by the Member States on the transport of dangerous goods and for the type-approval of vehicles used to carry dangerous goods respectively.
UNITED STATES	In the United States, the Hazardous Materials Transportation Act of 1975 (HMTA) is the major transportation-related statute affecting hazardous materials. In contrast to the international regulations, the HMTA addresses all means of transport within one piece of legislation. Thus, the HTMA can be applied to “any person who transports, or causes to be transported or shipped, a hazardous material; or who manufactures, fabricates, marks, maintains, reconditions, repairs, or tests a package or container which is represented, marked, certified, or sold by such person for use in the transportation in commerce of certain hazardous materials.” The enforcement of the HTMA is organized by the Secretary of the Department of Transportation and falls under the competence of different administrations, depending on the type of transport involved.

About the UNEP Division of Technology, Industry and Economics

Set up in 1975, three years after UNEP was created, the Division of Technology, Industry and Economics (DTIE) provides solutions to policy-makers and helps change the business environment by offering platforms for dialogue and co-operation, innovative policy options, pilot projects and creative market mechanisms.

DTIE plays a leading role in three of the six UNEP strategic priorities: **climate change, harmful substances and hazardous waste, resource efficiency**.

DTIE is also actively contributing to the **Green Economy Initiative** launched by UNEP in 2008. This aims to shift national and world economies on to a new path, in which jobs and output growth are driven by increased investment in green sectors, and by a switch of consumers' preferences towards environmentally friendly goods and services.

Moreover, DTIE is responsible for **fulfilling UNEP's mandate as an implementing agency for the Montreal Protocol Multilateral Fund** and plays an executing role for a number of UNEP projects financed by the Global Environment Facility.

The Office of the Director, located in Paris, coordinates activities through:

- **The International Environmental Technology Centre** - IETC (Osaka), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- **Chemicals** (Geneva), which catalyses global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- **Energy** (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies. This branch is also charged with producing green economy reports.

DTIE works with many partners (other UN agencies and programmes, international organizations, governments, non-governmental organizations, business, industry, the media and the public) to raise awareness, improve the transfer of knowledge and information, foster technological cooperation and implement international conventions and agreements.

For more information,
see **www.unep.org/dtie**

In many countries, Small and Medium Sized Enterprises (SMEs) form the heart of the industrial sectors where hazardous materials are manufactured. Regardless of company size, unsafe chemical manufacturing and handling can have serious impacts on workers, the environment and the wider community.

UNEP's Responsible Production Handbook – A Framework for Chemical Hazard Management for Small and Medium Sized Enterprises (2010) addresses chemical safety recognising that SMEs often have limited resources and expertise needed to efficiently address unsafe chemicals manufacturing and handling operations. It provides guidance and tools for managing risks associated with hazardous chemicals.

This Lessons Learned from Implementation report explains Responsible Production in the wider context of chemical safety and presents the results, feedback and lessons learned that UNEP has gathered from Responsible Production pilot projects in China, Egypt, El Salvador, India, Sri Lanka and Thailand as well as from global awareness-raising events. It highlights the pilot companies' experience of implementing risk reduction measures and shows how Responsible Production improves safety in the production, handling, use and transport of hazardous chemicals. It concludes with providing recommendations for the future RP activities.

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