

Using Sustainable Production Indicators to Measure Progress in ISO 14001, EHS System and EPA Achievement Track

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This case study presents results from testing a new tool — *indicators of sustainable production* (ISPs) — at Acushnet Rubber of New Bedford, Massachusetts. The authors demonstrate how the tool can be used to measure continual improvement and how it fits within the current system for reporting compliance to regulations; and performance under ISO 14001 (environmental management system standard), the environmental, health and safety (EHS) system, and EPA Achievement Track.

Developed at the Lowell Center for Sustainable Production (LCSP), this tool includes both core (common for all companies) and supplemental (production-specific) indicators, and aims to raise awareness, support decision-making, and promote continuous improvement toward sustainability. Indicators such as energy use, water use, global warming potential, lost work time case rate, turnover rate, community spending and charitable contributions, among others, were tested at both facility and corporate levels. Results showed the company's progress in EHS as well as the areas that need improvement. The paper concludes with a summary of key lessons learned and recommendations for further use of the tool. © 2001 Elsevier

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The beginning of the twenty-first century marked a growing movement toward promoting new tools for advancing business sustainability and measuring progress. Environmental management systems, design for the environment, industrial ecology, sustainability reporting, extended producer responsibility, full-cost accounting, are only a few of the currently used tools. Not much work, however, has been done to link those tools and explore how they can complement one another.

The current paper aims to address this gap and demonstrate how a new tool — *indicators of sustainable production* — can be used to assist measurement of continual improvement under ISO 14001 (environmental management systems), EHS (environmental, health and safety) system, and voluntary reporting under EPA Achievement Track Program.

The paper begins with some background information about the pilot company — Acushnet Rubber of New Bedford. The need for indicators to evaluate continual improvement is discussed next. Indicators of sustainable production are introduced as developed at the Lowell Center for Sustainable Production. The main part of the article focuses on the results of testing the indicators at Acushnet Rubber. The authors conclude with a summary of key lessons learned and recommendations for further use of the tool.

Acushnet Rubber Company — certified to ISO 14001, ISO 9001 and QS-9000

Acushnet Rubber Company, Inc. was established in 1910 in New Bedford, Massachu-

setts, to manufacture rubber products. Presently the company is a world-class producer of rubber and elastomeric products for the automotive industry and the electronic imaging markets. It makes high performance o-ring seals, gaskets and components for photocopier machines and laser printers, and employs about 1000 workers in its three facilities in New Bedford. In addition, the company has a plant in Bangkok, Thailand that employs 450 workers.

In November 1996 Acushnet Rubber Company, Inc. U.S. operations achieved ISO 14001 certification through TUV Management Services of Danvers, Massachusetts, and thus became the first company in the world to be certified to ISO 14001, ISO 9001, and QS-9000 (the American automotive industry) standards.

In 1999, the company (U.S. operations) joined U.S. EPA's pilot program Star Track. In December 2000, it became a charter member of EPA's National Achievement Track. Both programs require maintaining an environmental management system (EMS) that exceeds the commitments under ISO 14001.

Acushnet Rubber has a mature EHS management system and has implemented various projects for reduction of material and energy use, prevention of pollution, and reduction of waste. The annual cost savings of environmental projects currently exceed \$2 million.¹ As a result of these strategies, Acushnet's environmental performance has improved, material and regulatory costs have declined, and the company has doubled its production, adding 200 jobs since 1990.²

At the same time, Acushnet realizes the importance of transparency. Its logo "*Connected to your needs, committed to your success™*" represents management's commitment to involve and communicate with all interested parties including local community,

customers, government agencies, subcontractors, and employees.²

Why Would A Company Need Indicators?

There is an old saying that you can't manage what you don't measure. When it comes to measuring business performance, management needs to know whether a company/facility is achieving established goals and objectives and how it compares to others in the sector. Traditionally financial and quality indicators have been used to benchmark performance (e.g. return on investment, market share, rate of returns and complaints, rate of defect products). With the growth of the environmental and sustainability movement, however, companies are realizing the importance of improved environmental and social performance. The latter can save money, improve a company's image, build competitive advantage and thus improve the bottom line. A growing number of studies reveal the link between good environmental and social performance and financial results.^{3,4} Furthermore, with the help of the Internet, customers today are more powerful than ever before. They constantly need to be convinced that a company is doing what it has promised to do. Monsanto and Nike are two examples of how a poor environmental or social record led to a decline in stock value and profits.⁵ Therefore, an increasing number of companies are making commitments toward environmental and social responsibility and need new tools to benchmark progress.

Acushnet Rubber has traditionally been a leader in the environmental field. Not only has it achieved impressive improvements in water and electricity conservation, elimination of toxics and reduction of waste and emissions but it is constantly looking for ways to further improve its performance. This commitment to continual improvement is reflected in Acushnet's excellent compliance record as well as in the company's goals

under ISO 14001, EHS system, and EPA Achievement Track.

Mandated by regulations such as SARA 313 and the Toxics Use Reduction Act in Massachusetts, Acushnet Rubber has been measuring and reporting its chemical use, emissions and waste.¹⁷

Developed in 1996 by the International Organization for Standardization, ISO 14001 has become a proven business model for environmental management. It has been adopted by companies throughout the world as the way to manage their operations with regard to environmental impacts. One of the fundamental premises of ISO 14001 is that a company commits itself to continual improvement. The identification of environmental indicators that will be used to achieve continual improvement can be a key step in the development of a successful ISO 14001 environmental management system.

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The EPA's National Environmental Achievement Track is a voluntary initiative, designed to "recognize facilities that consistently meet their legal requirements and have implemented high-quality environmental management systems as well as to encourage them in achieving more by continuously improving their environmental performance and informing and involving the public".⁶

Both ISO 14001 and EPA Achievement Track require a company to make commitments to continual improvement by setting goals and targets, and to measure performance in order to demonstrate success. In addition, Acushnet wanted to be able to make comparisons over time and relate environmental metrics to facility output. For the company, to meas-

ure progress over the long-term means to relate consumption of raw materials and the generation of waste and emissions to the production of goods and services. Waste means inefficiencies in the production process; therefore eliminating it will lead to improved bottom line. Thus the system for measuring environmental impacts is emerging into a system of measuring production efficiency. Acushnet Rubber, however, is aware that impacts of its production go beyond its facility boundaries. Embedded energy in transportation, packaging, product use and distribution leads to depletion of resources, acidification, smog, and global warming, among others. Therefore, the company is beginning to think how to reduce its impacts over the life cycle of materials and products.

Clearly, measurement is the key toward providing the necessary information for making decisions, benchmarking achievements and promoting continual improvement. Although there have been numerous attempts to develop environmental and sustainability indicators for business, no consensus has been achieved on a common set of indicators.^{7,8} The Global Reporting Initiative has currently the best potential for becoming such a tool and yet, it does not provide a clear vision or guidance for practical application. Furthermore, its complex framework and reporting requirements are extremely burdensome for small and mid-size companies like Acushnet Rubber.⁸

Through its strong relationship with the University of Massachusetts Lowell and the Toxics Use Reduction Institute, in the year 2000 Acushnet Rubber volunteered to test a new tool for benchmarking achievements — indicators of sustainable production.

Defining Indicators of Sustainable Production

The Lowell Center for Sustainable Production (LCSP) defines *sustainable production* as

“the creation of goods and services using processes and systems that are non-polluting; conserving of energy and natural resources; economically viable; safe and healthful for employees, communities and consumers; and socially and creatively rewarding for all working people”.⁹

This definition is consistent with the current understanding of sustainable development, since it emphasizes environmental, social and economic aspects of a firm’s activities. At the same time it is more operational, since it highlights six main aspects of sustainable production: energy and material use (resources); natural environment (sinks¹⁸); social justice and community development; economic performance; workers; and products.

...indicators can be applied to evaluate both impacts within facility boundaries and throughout supply chain and distribution.

To promote a better understanding of sustainable production the LCSP has formulated nine guiding principles. These principles address issues, such as the designing of products and packaging, the elimination of waste and incompatible byproducts, the minimization of work-related hazards and the continual enhancement of worker and community development and well-being.¹⁰ Indicators of sustainable production (ISPs) were developed as a tool to assist companies in measuring and managing the different aspects (environmental, social and economic) of their production.

The methodology for ISPs involves using *core* (common for all companies) and *supplemental* (production-specific) indicators. Veleva and Ellenbecker¹¹ propose twenty-two core indicators that are classified into six

Sustainable Production Indicators

Table 1 *Core indicators of sustainable production*⁹

#	Indicator
I. Energy and material use (resources)	
1	Fresh water use
2	Materials used
3	Energy use
4	Percent of energy from renewables
II. Natural environment (sinks)	
5	Waste generated before recycling
6	Global warming potential
7	Acidification potential
8	Amount of PBTs used
III. Economic viability	
9	EHS compliance costs
10	Customer complaints and/or returns
11	Organizational openness
IV. Community development and social justice	
12	Community spending and charitable contributions
13	Number of employees per unit of product/\$ sale
14	Number of community-company partnerships
V. Workers	
15	Lost workday injury and illness rate
16	Rate of employee suggested improvements.
17	Turnover rate or average length of service
18	Average number of hours of employee training.
19	Percent of workers who report complete job satisfaction
VI. Products	
20	Percent of products designed for disassembly, reuse or recycling
21	Percent of biodegradable packaging
22	Percent of products with take-back policies

categories, corresponding to the six main aspects of sustainable production (see Table 1). Examples include total water use, energy use, global warming potential, lost workday injuries and illness rate, etc. Each of these indicators is calculated as a total and as a production adjusted measure (per unit of product, dollar sales, etc.).

Proposed indicators can be applied to evaluate both impacts within facility boundaries and throughout supply chain and distribution. A continuous, eight-step model for selecting and implementing indicators guides the integration of this process within the EMS and/or business decision-making system.¹¹ The steps include: (a) defining sustainable production goals and objectives; (b) identifying

potential core and supplemental indicators; (c) selecting indicators for implementation; (d) setting targets; (e) implementing the indicators; (e) monitoring and communicating results; (f) acting on results; and (g) reviewing and revising the indicators, policies and goals.

This eight-step model can be directly linked with the implementation and maintenance of a successful ISO 14001 environmental management program. Acushnet Rubber is required by ISO 14001 to identify its environmental aspects and determine which of these aspects are considered significant. The company establishes objectives and targets, and a management plan of how to reach these in practice.

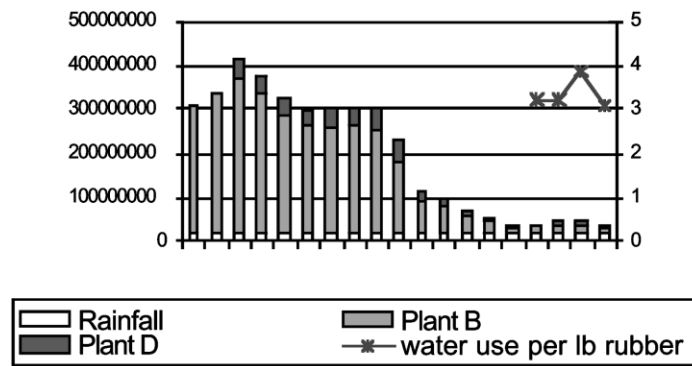


Figure 1 *Acushnet Rubber — Total Water Consumption.*

Results from implementing the indicators at Acushnet Rubber

ISPs were welcomed at Acushnet Rubber as a useful tool to measure performance (primarily environmental) and demonstrate continual improvement under ISO 14001 and EPA Achievement Track. The process of implementation involved the following key steps:

1. Identifying the company's environmental, health and safety goals and targets
2. Collecting data for implementation of the core indicators
3. Selecting additional production-specific indicators to reflect key environmental aspects and impacts and company's goals
4. Selecting a unit for normalizing the indicators
5. Calculating the indicators (both core and supplemental)
6. Interpreting obtained results and initiating an appropriate action

The indicators applied at Acushnet measured both total (e.g. total energy use) and production-adjusted parameters (e.g. energy use per unit of rubber). The total measurement is important to assess the overall contribution of the company in terms of water use, global warming potential, and acidification potential, among others. Normalization, however, is particularly useful when evaluating continual improvement under ISO 14001. It allows

adjusting for fluctuations in the production level as well as making comparisons between different companies or facilities (external benchmarking). Since the product mix at Acushnet varies greatly from year to year, a unit of "pounds rubber mixed" was selected for normalization. The latter is closely correlated to most applied indicators (e.g. energy use, water use, injuries and illnesses, complaints and returns).

Next section details the results for some of the indicators used at Acushnet Rubber.

Core Indicators (common for all companies)

Water use was the first core indicator tested at Acushnet Rubber. Scarcity of fresh water is often considered a key environmental problem in many parts of the world, therefore making it critical to reduce consumption and reuse process water. The indicator measured not only the use of city and groundwater, but also the rainfall on Acushnet's property. Figure 1 presents both total and production-adjusted amounts in gallons per year, and demonstrates significant reductions achieved over the past nineteen years. In 2000 the company established a new goal under EPA Achievement Track for further reducing water consumption by 5% over a three-year period. In addition, Acushnet is now considering rainwater collection as a way to further reduce its water use.

Sustainable Production Indicators

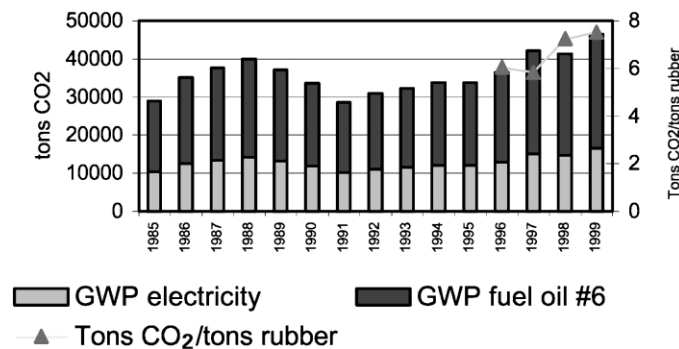


Figure 2 Acushnet Rubber Global Warming Potential.

Materials used is a core indicator that includes all materials except fuel and water, and is commonly found in environmental and sustainability indicator sets (e.g. Global Reporting Initiative, World Business Council for Sustainable Development Eco-efficiency Indicators, and Center for Waste Reduction Technology sustainability metrics). However, it was very difficult to use, due to the lack of a good system for tracking all materials. Similar results were obtained when testing the indicator at other companies and facilities.¹² Concerns were further raised that material intensity (materials used per pound of rubber) may not be a good measure due to the quickly changing product mix (e.g. size and weight of products). One possible solution is to modify the indicator as “Take-Make-Waste” and measure percent of materials that become waste (or production efficiency) — an approach taken by Interface Inc.¹³ For example, Acushnet has begun work on a project called GEN II (a wasteless, flashless injection moulding process) that will cut energy use and rubber waste by 35%.

Energy use is a core indicator measured in MM Btu (million British Thermal Units) that aims to aggregate the contribution of different energy sources. Acushnet Rubber, for example, uses fuel oil #6, electricity and natural gas. Tracking these sources separately was particularly useful for internal management and decision-making. For example, this indicator uncovered increasing electricity

use, which is both an environmental and economic concern. To address the problems an energy team was formed and a new goal for 10% reduction in electricity use over the next three years was established (as part of the EPA Achievement Track commitments). Currently Acushnet is working on the replacement of lighting, utilization of T5 fluorescent tube technology and the implementation of an automated energy management system.

The core indicator *Global Warming Potential* (GWP) was very difficult to calculate beyond facility boundaries — a common result for most companies that attempt to use it.¹² This is due to the large scale of production and the lack of a good system to track transportation of raw materials and products, employees’ commuting, packaging and other materials on a yearly basis. Lack of conversion factors to calculate embedded energy in key materials and products is an additional constraint. Figure 2 presents Acushnet’s facility GWP, which reflects only the use of electricity, fuel oil and natural gas. Studies demonstrate that facility GWP is only a small fraction of the total global warming impact of a company over the life-cycle of its materials and products.¹² The measurement of facility-level GWP, however, is a first important step and gives companies a way to visualize the impact of their energy-related decisions and strive for improvement.

Amount of PBTs (persistent, bio-accumulative and toxic chemicals) is another core

indicator that was tested at Acushnet Rubber. The company does not use such chemicals in its production but it uncovered the presence of PACs (Polycyclic Aromatic Compounds) in fuel oil #6 used for heating. PACs will have to be reported beginning in June 2001 under the new amendment of the Toxics Release Inventory (TRI), which lowered the thresholds for eighteen PBTs. Acushnet estimated the amount of PACs emitted annually to be 0.126 pounds but it triggers TRI reporting because of its fuel consumption. The company is currently developing strategies to minimize its impacts through switching fuels and improving boiler efficiency.

Number of employees (total and per pound of rubber mixed) aims to measure a company's contribution to creating more jobs for the local community. In a time when natural resources are becoming scarce and labor is abundant,¹⁹ the goal should be to increase labor intensity (number of people employed) and reduce material intensity (amount of resources used per unit of product) of production.^{14,15} When more people are employed, more people will have the purchasing power to buy products and services and this in turn will lead to improved business bottom line.

Acushnet Rubber presently measures the full-time equivalent employees (FTE) by dividing the total hours worked per year by 2000 (an estimated number of work hours per person per year, based on a 40-h work week, 50 weeks per year). Results demonstrate that the number of FTE has increased since 1995. This indicator was presently not considered particularly useful to management, since changes in the product mix and pounds of rubber processed may lead to different labor requirements. However, the management felt that it might be more valuable in future, when the emphasis on recycling, reuse and take-back programs will lead to higher labor intensity and lower material intensity.

Lost workday injury and illness (LWDII) rate was selected as a core indicator, since it is a standard measure reported by the Bureau of Labor Statistics (BLS). All companies are required to track and report it and thus comparisons can easily be made. The indicator is calculated with the following formula:

$$\text{LWDII} = (\text{Number of injuries and illnesses} \times 200,000) / \text{Employee hours worked}$$

where 200,000 is the base for 100 equivalent full-time workers, working 40 hours per week, 50 weeks per year.

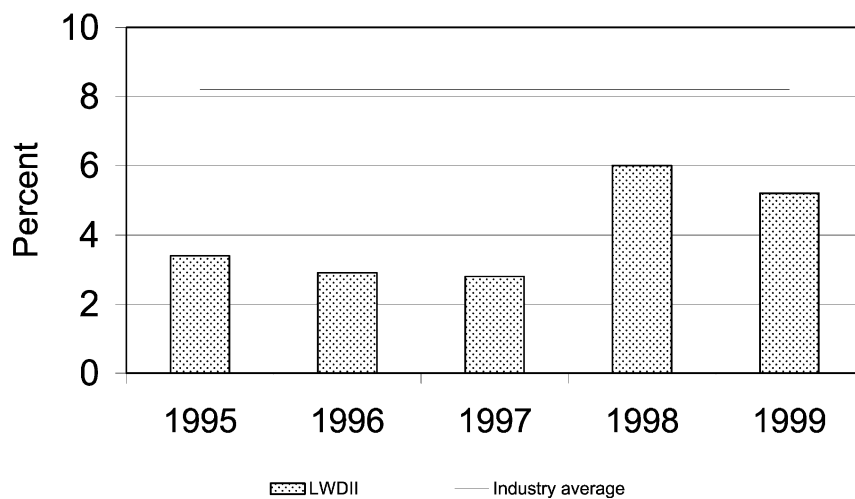


Figure 3 Acushnet Rubber injuries and illness rate.

In addition to this indicator, Acushnet Rubber measures total incident rate and lost work-days per 100 employees. Although the company has not improved its safety record over the past five years, it is still less than half of the industry average (see Figure 3). The most prevalent type of accidents in 1999 (54%) were sprains, strains and other injuries from moving materials or loading equipment. The next most prevalent type of accidents were slips and falls on the stairs, platforms and icy conditions in the parking lot (8% of accidents in 1999). Most accidents happened during 1st shift (52%). Acushnet has identified that additional work is required to improve performance and has instituted a program to achieve a goal of zero lost time accidents.

It is important to note that LWDII is a *lagging* indicator and does not allow for quick action upon review of the results. Furthermore, it measures only injuries and illnesses that are associated with lost time, while most of the work-related incidents do not require taking time off. More importantly, in many cases there is a strong pressure on workers not to report (underreporting). Even such a drastic workplace injury as death has been greatly underreported.¹⁶ Therefore, better measures of worker health and safety are needed in future, such as “near-misses”, “investment in injury prevention”, “employee safety training”.

Continuous training of employees is critical for the business success of a company.

Continuous training of employees is critical for the business success of a company. It improves performance (quality, efficiency, environmental, health and safety), employee job satisfaction, promotes organizational learning and thus builds a long-term competitive advantage. Although Acushnet gives appropriate EHS training to its employees

and typically spends over \$100,000 annually, it was not possible to implement the indicator “*average number of hours of employee training*”. The difficulties arose from (a) the lack of a system to track training on an hourly basis; and (b) the high turnover rate. As a result of the indicator project, however, a decision was made to begin tracking EHS training on an hourly basis as well as measure its effectiveness as a way to strive for improvement.

Products are a key element of sustainable production, since they are linked to environmental, social and economic impacts of a firm. At the same time, due to the large variety of products, this aspect is the most difficult to address in a standardized set of indicators. Veleva and Ellenbecker¹¹ suggest three core indicators to address products: (a) percent of products designed for disassembly, reuse and recycling; (b) percent of biodegradable packaging; and (c) percent of products with take-back policies in place.

Designing products that can be reused or recycled reduces raw material use and thus the burden on ecosystems (e.g. land for waste disposal, assimilative capacity of waters, air and soils). In addition, it may lead to significant savings and improved bottom line (e.g. less money spent on raw materials, emission permits, and waste treatment or disposal). *Percent of products designed for disassembly, reuse and/or recycling* was currently difficult to measure at Acushnet mainly due to the large number of products and quickly changing product mix. 95% of the company’s products can be recycled, most of which involves down-cycling. For example, waste rubber can be used in asphalt to build roads. Another difficulty in implementing such an indicator arises from the fact that often customers do not allow the use of recycled product for safety reasons (e.g. automobile industry). With the increasing pressure for take-back, reuse and recycling, however, this indicator will likely become more useful in future. Its implementation will

require setting a good tracking system for products.

The indicator “*Percent of biodegradable packaging*” addresses the problem of materials such as plastics, which can stay indefinitely in the environment, and when manufactured, recycled or incinerated may produce toxic emissions (e.g. dioxin from PVC) that can affect workers, community and ecosystems. There is a growing movement to restrict and even ban the use of such chemicals (e.g. Persistent Organic Pollutants (POPS) Convention, EPA’s PBT list, and endocrine disrupting substances).

Currently this indicator is difficult to use, since companies do not maintain adequate records of their packaging deliveries and use.¹² At Acushnet Rubber it was possible to estimate only roughly the amount of biodegradable packaging. Results showed that approximately 98% of the company’s packaging is corrugated cardboard (which consists of cellulose and is organically based), one percent is wood (biodegradable) and the rest — approximately 1% — is plastic (non-biodegradable). Acushnet is currently recycling its cardboard and wood packaging, and is exploring the feasibility of switching to reusable containers.

...supplemental indicators should be developed with the wide participation of all employees and other stakeholders.

Results from measuring “*Percent of products with take-back policies in place*” revealed that presently Acushnet has only one such product — a blade for Xerox copy machines. Required by the customer (Xerox), Acushnet takes back the blade and sends it for reclamation of the metal. When heated, the metal (95% of the product) can easily be separated from the urethane (5% of the product) and reused.

Supplemental Indicators (specific for Acushnet Rubber)

According to the methodology for using ISPs,¹¹ supplemental indicators should be developed with the wide participation of all employees and other stakeholders. Due to limited time and resources, this was not done under the current project. Four supplemental indicators were constructed with the help of the EHS staff to reflect Acushnet’s goals and targets. They address either compliance issues or commitments under ISO 14001 and EPA Achievement Track, and are described below.

- *SARA 313 emissions.* The company completely eliminated the use of trichlorethylene (TCE) in 1997 and has reduced its use of chlorine and xylene below the threshold levels of 25,000 lb and 10,000 lb, respectively. Currently the only significant SARA 313 emissions are zinc emissions, which are less toxic than TCE, chlorine and xylene. Zinc oxide is present in natural rubber, and zinc acrylate and zinc stearate are used in the production of golf balls (specifications are provided by the customer), therefore it is difficult to eliminate zinc compounds. The increasing zinc emissions over the last three years are partly due to the reduced recycling rates for waste rubber.²⁰
- *Lead Use.* Although its products contain less than 1% lead, Acushnet Rubber made the commitment under ISO 14001 to completely eliminate the use of lead in three years (beginning in 1999). The pressure comes primarily from customers. Currently, Acushnet Rubber uses lead in the adhesive for one product line.
- *TURA reportable chemicals.* For the period 1992–1998 the company has reduced its use of Massachusetts TURA reportable chemicals from 2,235,900 lb to 75,313 lb. Currently zinc and chlorine are the only reportable chemicals. While it is not technically feasible to eliminate zinc, it is possible to completely phase-out chlorine. As part of EPA’s Achievement Track and ISO

14001 commitments, Acushnet Rubber has set a goal to completely eliminate chlorine use in three years.

- *Source registration emissions.* This indicator measures the emissions that require a permit from the Massachusetts Department of Environmental Protection, and includes total suspended particles (TSP), volatile organic compounds (VOC), carbon monoxide (CO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and particulate matter (PM₁₀). Under the EPA's Achievement Track commitment the company established a goal of 50% reduction in its VOC emissions over a 3-year period (beginning in 1999). The rest of the emissions are related to combustion of fuel oil #6 and no alternative is presently available that is both economically and technically feasible. However, projects to improve boiler efficiency by 2% are underway, which will lead to fuel cost savings and lower emissions.

How ISPs can support ISO 14001

The use of indicators can assist ISO 14001 program in measuring improvements over time. The early identification of such indicators allows a company to decide what projects to initiate in order to demonstrate continual improvement. It is relatively simple to identify individual environmental improvement projects for a given year, but in doing so the long-term improvement picture becomes blurred. If environmental indicators are chosen early on, their measurement and reporting can mature over time, similar to the EMS itself. Business plans and financial indicators have long been used to guide companies toward success, now environmental indicators can help them gain long-term efficiency benefits.

An important consideration when setting an indicator system is to measure both total and normalized amounts. When ISO 14001 was first introduced many companies established basic targets and objectives and later found

that these were unattainable due to unforeseen changes in production volumes. The overall goal of ISO 14001 is to have successful companies that are also environmental achievers. It is considered an indication of prosperity when an ISO 14001-certified company increases its production. Well-defined targets and objectives that use normalized, quantifiable indicators to evaluate progress are usually the ones that prove useful for management. Examples of such indicators are gallons of water used per pound of rubber produced or kWh of electricity used per employee work hour.

The use of the core indicators of sustainable production brings ISO 14001 companies to the next level.

The use of the core indicators of sustainable production brings ISO 14001 companies to the next level. It creates the foundations for benchmarking between companies and industries. The indicators such as water use, energy use, and global warming potential are ideal for this purpose. Imagine the power of an entire industry moving together on a particular aspect of environmental improvement? Until now this type of momentum has not been possible, since companies typically have developed their programs individually. During peer reviews or industry roundtable discussions, business leaders have been left to compare apples with oranges when it comes to measuring and evaluating environmental performance.

It is important that ISO 14001 retains its flexibility so that companies across industries can set their own pace of improvement, but the lack of guidelines on how to best measure success has left many managers frustrated. There is currently no standardized approach to guide the measurement and achievement of environmental targets and objectives. It is likely that such guidance will

be developed in future as increasing number of companies recognize the need of a standardized environmental indicators. The ISPs model with the use of core and supplemental indicators in its first pilot study shows promising results of how companies can structure their long-term improvement efforts and achieve environmental sustainability.

Conclusions and recommendations

This paper demonstrated how indicators of sustainable production can be used to support ISO 14001, EPA Achievement Track and other voluntary initiatives in measuring continual improvement. In order to be useful these indicators need to be linked to company's goals and targets; have upper management commitment; involve employees and other stakeholders; provide both total and production adjusted measure of performance; and be based on a good system for tracking various data, among others.

It is also important to note that ISPs go beyond the scope of ISO14001, EHS system and EPA Achievement Track to address social issues, worker well-being and economic viability. It is expected that as companies embrace social responsibility they will move toward more integrated measurement and reporting of their performance (environmental, social and economic). The tool further allows addressing impacts beyond facility boundaries, over the entire life-cycle of products and services.

It is clear that ISPs alone can not change the current production paradigm. Strong government policies, top management support and consumer and investor pressures are among the key factors that can foster the transition to more sustainable production systems. What ISPs can do for companies today, however, is to raise awareness, support decision-making and promote continual improvement.

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 17. SARA is the Superfund Amendments and Reauthorization Act of 1986 in the United States. Section 313 relates to the toxic chemical release inventory reporting (TRI). The Massachusetts Toxics Use Reduction Act (TURA) was passed in 1989 with the goal to reduce the generation of hazardous wastes in Massachusetts. It encourages firms to establish planning teams and engage the workforce in analyzing production processes, conducting materials accounting programs, auditing health and environmental regulations, and identifying TURA reduction options.
 18. Environmental sinks relate to the assimilative capacity of ecosystems or their ability to absorb and eliminate the waste and residual byproducts of consumption and production (e.g. air and water purification, soil degradation).
 19. This refers to the global employment trends and not the ones in the United States, where unemployment in the year 2000 reached its lowest point of 3.9% in 30 years.
 20. The recycling facility in New Bedford stopped accepting waste rubber due to reduced demand for its product.