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*We Protect Hoosiers and Our Environment.*
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# P2 Strategies Guide for Indiana Businesses

## 1) Integrate Environmental Considerations into the Business Planning Process

Implement Cost Accounting – Experience has shown that the most successful P2 programs account for the true cost of wastes through cost accounting. In order to implement cost accounting, a business must allocate and charge for the direct and indirect costs of all air, land, and water discharges to specific processes, products, or departments. This includes expenses for lost raw materials, staffing, paperwork and insurance, sample analyses, utilities, material management, and waste management (handling, storage, treatment, and disposal).

Implement an Environmental Management System (EMS) – An EMS is a set of processes and practices that enable a business to reduce environmental impacts and increase operating efficiency. An EMS helps a business identify and implement P2 opportunities. It also provides the framework needed to track, measure, and continually improve environmental performance. The EMS provides a cost-effective, convenient, and systematic way to demonstrate environmental stewardship and accountability. The most commonly used schema for defining criteria of an EMS is the International Organization for Standardization (ISO) 14001 standards. ISO 14001 is known as a generic management system standard that is relevant to any organization seeking to improve and manage resources more effectively. ISO 14001, like other ISO 14000 standards, is voluntary. The goal is to assist companies in continually improving their environmental performance and complying with any applicable legislation.

Provide Support for the P2 Program – In order to effectively implement P2, facility P2 goals need to be considered as part of the company bottom line through cost accounting and allocation of company resources. Access to corporate resources, such as engineering, marketing, research, and laboratories services, must be available to aid P2 efforts. The company should utilize quality tools for program development and management, such as team-based quality culture, ISO 9000/14000, total quality control, Six Sigma techniques, etc.

Best Management Practices – A facility must update standard operating procedures (SOPs) to incorporate P2 and assist with total cost accounting

practices. These updates should document waste stream segregation, utility metering for individual unit processes, recordkeeping, and communication practices for purchasing, receiving, and regulatory compliance.

**2) Process and Equipment Optimization, Redesign, Modification, or Modernization**

Process design techniques can be used in new or existing facilities to improve operating and material use efficiency. These system designs or upgrades can also reduce the frequency of off-spec production, reduce other waste generation, and isolate waste streams for better management. New processes can be designed using modern technology and engineering practices, or existing units can be retrofitted or replaced to increase precision. Examples include:

Process and Equipment Optimization

- Make system adjustments to existing processes such as flow rates, temperature, pressure, or residence times to optimize functions.
- Change equipment or infrastructure (i.e., plumbing) location or layout to minimize material transfers, pressure losses, and slowed flow rates.
- Adjust equipment and process operations to optimize cleaner (solvent) concentrations and cleaning times.
- Keep lids and covers closed to reduce evaporation losses from cleaning and dip tanks.
- Remove sludge and surface oils/scum from cleaning and dip tanks to extend solution life.
- Make sure that parts being cleaned in a degreaser/defluxer are positioned in a manner that permits maximum drainage and minimizes dragout (whether contained in baskets, suspended from hooks or racks, or conveyed on a belt).
- Implement water conservation practices to reduce the use of water and chemical inputs to water.

Equipment Modification and Modernization

- Buy and maintain durable equipment / upgrade tool and equipment quality.
- Install high-performance nozzles and applicators.

- Install or make better use of automation equipment and process controls such as thermostats, shut-off valves, or flow meters.
- Install mechanical alarms to notify of leakages and process bypasses.
- Replace high-volume hoses with high-pressure, low-volume systems.
- Use devices such as blower-powered air knives to contain or remove free-standing materials to reduce chemical cleaning practices.
- Install splash guards and drip boards to minimize solvent and chemical losses.
- Install floating covers on heated baths to extend solution life by reducing evaporative losses.

Process and Equipment Redesign

- Design continuous closed systems to replace batch processes.
- Install holding tanks or other equipment to segregate waste streams.
- Design or retrofit units to use energy / fuel sources that are renewable or cause fewer emissions.
- Redesign refrigeration units to use non-ozone depleting refrigerants.
- Redesign or implement alternative cleaning processes to reduce solvent and toxic chemical usage in the manufacturing process by:
    - Determining the true degree of cleanliness needed for equipment or process materials to eliminate redundant cleaning practices that are deemed unnecessary.
    - Reviewing upstream and downstream processes / practices and accurately determine how they influence the cleaning practices in the process.
    - Modifying employee practices to improve solvent handling and storage procedures to reduce waste generation.
    - Researching and studying the chemistry, mechanics, and other fundamentals of cleaning and understanding the pros and cons of potential alternatives or if experimentation is needed.
    - Utilizing alternative cleaning technologies or chemical solutions such as:
        - Aqueous and semi-aqueous cleaning processes
        - Thermal and steam cleaning processes

- Abrasive blasting using bead, dry ice, baking soda, starch, plastic, and other media
- Supercritical carbon dioxide solvent cleaning
- Less hazardous solvents with low vapor pressure, low toxicity, and non-ozone depleting characteristics (i.e., lactic acid, dimethyl esters, dimethyl sulfoxide, n-methyl pyrrolidone, glycol ethers, terpenes, soybean, and other bio-based solvents)
- Implementing in-process recycling by installing equipment or methods that become integral to production through hard-piped or closed-loop systems

- Using distillation, filtration, or vapor recovery (i.e., refrigerated condensation) equipment to capture and reclaim cleaning or process chemicals such as solvents, oils, and toxics.
- Installing counter-current rinsing systems and using spray nozzles as part of a rinse system instead of single rinse tanks.
- Utilizing regeneration processes (chemical or mechanic).
- Installing efficient condensers, regenerative heat exchangers, heat pumps, or similar equipment to recover and reuse heat.
- Recycling and reusing spent water through grey water use (when appropriate), ultrafiltration / nanofiltration systems, reverse osmosis purification, filter presses, high capacity angled plate clarifiers, or batch treatment systems.

**3) Product Design, Product Reformulation or Redesign, Product Stewardship, and Sustainable Development**

Product design, reformulation, or redesign for P2 incorporates environmental objectives with minimal loss to the product's performance, useful life, or functionality. The product's initial composition or reformulation should be nontoxic, or less toxic, to ensure environmental protection and consumer safety. Designs should consider the feasibility of the final product to be reused, recycled, and disposed of in environmentally sound manners. Examples include:

<u>Product Design, Stewardship, and Sustainable Development</u>

- Integrate P2 into pre-manufacturing decisions by beginning P2 at research, development, and design phases of the product. Also include P2 into equipment and materials procurement for the production of the product.

- Design and create products or services that are ecologically safe throughout their life cycle,
- Introduce new product lines specifically designed to eliminate or reduce the use of toxic chemicals,
- Design durable products (extend product life span),
- Design products that allow for resale, reuse, or are conducive to recycling (i.e., plastic parts are marked to aid recycling) instead of immediate disposal,
- Use modular and upgradeable designs allowing for easy repair, replacement of component parts, and upgrades (thus lengthening the useful life of the product),
- Produce combined, condensed, or concentrated products that require less packaging,
- Minimize the use of product fillers.
- Utilize materials and parts that can be reused or recycled during production.
- Use natural, renewable, or recycled materials in manufacturing processes.

<u>Product Reformulation or Redesign</u>

- Eliminate raw materials that are not incorporated into final products or services.
- Substitute raw materials by:
    - Using organic or aqueous-based materials instead of petroleum, solvent, or toxic chemical-based inputs / ingredients.
    - When toxics are required, use the least toxic alternative available.

## 4) Purchasing and Inventory Management

An efficient and coordinated material-purchasing program can be achieved through monitoring of all requests for products throughout the company or plant. Improved inventory control and judicious purchasing can significantly reduce the disposal volume of raw materials because they become outdated.

- Implement "just in time" purchasing (in quantities matching process demand), as the cost associated with the disposal of surplus hazardous materials often exceeds the purchase price of the items.

- Purchase frequently or commonly used products in bulk or in concentrated form.
- Prioritize purchasing locally to reduce transportation and storage needs.
- Purchase durable, long-lasting materials.
- Implement a computerized inventory control program that:
  - Promotes sharing of materials between common users
  - Provides data on what processes use hazardous products
  - Identifies large volume users
  - Locates unused caches of materials
  - Identifies where waste reduction / material substitution options are viable
  - Rotates stock on a first-in, first-out basis and monitors expiration of materials
- Avoid unnecessary purchasing by reusing materials / equipment (i.e., drums, pallets, boxes) or by participating in a material exchange program (allows the movement of unwanted materials between companies).

**5) Improved Maintenance, Preventative Maintenance, and Housekeeping**

Equipment components start to wear over time. By maintaining equipment in optimum working condition, a facility can reduce off-spec production and prevent unplanned downtime resulting from breakdowns. Preventing operational problems from occurring through repair, replacement, or adjustments will almost always cost less than the potential consequences of actual failures while in service.

- Establish schedules and procedures for routine inspections.
- Regularly conduct key maintenance activities and system adjustments (i.e., calibration, air to fuel ratios).
- Identify equipment or systems that frequently malfunction and implement preventative measures.
- Repair equipment instead of purchasing new whenever possible.
- Maintain a supply of spare parts for equipment that needs frequent repair.

- When repair is not possible or economically beneficial, replace defective equipment promptly.
- Update system maintenance and monitoring software regularly.
- Modify existing equipment or methods through improved housekeeping or process / product inspections.
- Implement spill prevention training and procedures.

### 6) Improved Receiving and Distribution Practices

A second look at the transportation and product packaging that companies send and receive often leads to waste reduction without sacrificing product safety or quality.

- Work with suppliers and transporters to implement the use of lightweight, returnable, and reusable containers for shipping and receiving.
- Reduce or eliminate excess product packaging.
- Increase the use of recycled or recyclable packaging.
- Ship products in bulk or in concentrated form.

### 7) Green Building, Infrastructure, and Sustainable Grounds Management

The green building practice (also known as green construction or sustainable building) expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building refers to both a structure and the application of processes that are environmentally responsible and resource-efficient throughout a building's life cycle. A structure's life cycle takes into account the following: planning, design, construction, operation, maintenance, renovation, and demolition. Green infrastructure is a P2 approach to managing wet weather impacts (i.e., flooding) and provides many property and community benefits. Green infrastructure uses vegetation, soils, and other elements to restore some of the natural processes required to reduce and treat stormwater at its source while delivering environmental, social, and economic benefits. When installing new buildings and infrastructure, or when remodeling existing structures, green design practices should be utilized. This often requires close cooperation of the contractor, architects, engineers, and the company representatives.

*Green Building*

- Use life cycle thinking in all engineering activities and ensure that all material and energy inputs and outputs are as inherently safe and benign as possible.
- Install a skylight system and design window placement to provide more natural light and lessen the need for electric lighting during the day.
- Orient windows, walls, and awnings with trees to shade windows and roofs during the summer while maximizing solar gain in the winter.
- Reduce heat gain by tinting windows.
- Reduce infiltration / exfiltration (air leakage) by insulating the building envelop, installing high-performance windows, and adding extra insulation in walls, ceilings, and floors.
- Generate renewable energy for building use through solar power, wind power, geothermal power, or hydropower.
- Install solar water heating units where feasible.
- Install personal temperature and airflow controls over the HVAC system.
- Design systems to collect, purify, and reuse water on-site (e.g., dual plumbing that recycles water into toilets (flushing) or for use of non-sewage and grey water for site irrigation).
- Utilize water conserving fixtures such as ultra-low flush toilets and low-flow faucets.
- Install "point of use" water treatment and heating (improves water quality /energy efficiency).
- Install a hybrid central chilled water system (cools floor-by-floor with steam instead of water).
- Use zero or low VOC-emitting construction materials and interior finish products.
- During the construction phase, reduce the amount of material going to landfills.

*Green Infrastructure*

- Reroute rooftop drainage pipes from draining rainwater into the storm sewer to draining it into rainwater harvesting systems, cisterns, or permeable areas.

- Install bioretention or bioinfiltration cells (shallow, vegetated basins that collect and absorb run-off from rooftops, sidewalks, and streets).
- Install vegetated swales to slow, infiltrate, and filter stormwater flows along streets and parking lots.
- Use permeable pavements made of pervious concrete, porous asphalt, or permeable interlocking pavers to infiltrate, treat, and/or store rainwater where it falls.
- Create green parking by using permeable pavements in sections of a lot and adding rain gardens and bioswales in medians and along the perimeter.
- Install green roofs that are covered with growing media and vegetation that enable rainfall infiltration and evapotranspiration of stored water. They are particularly cost-effective on large industrial or office buildings where stormwater management costs are likely to be high.
- Plant trees on-site to reduce and slow stormwater by intercepting precipitation in their leaves and branches.

*Sustainable Grounds Management*

- Convert lawns to natural areas (e.g., prairies) with a diversity of native plants (e.g., wildflowers, groundcovers, and grasses). This practice helps prevent pollution from mowers and lawn chemicals, reduces maintenance costs, promotes biodiversity, and provides a sanctuary for flora and fauna. These areas can help manage storm water run-off and alleviate flooding, while simultaneously providing recreation and/or aesthetic amenities that can beautify company grounds and improve the surrounding community's quality of life.
- Monitor the growth of remaining lawns and only mow when necessary. For example, a church in Indianapolis avoided 15 mows in 2016 via its "mow-upon-call" system, saved over $2,000 in mowing costs, and reduced the church's carbon emissions.
- Leave grass clippings where they fall to facilitate recycling nutrients back into the soil. If clippings are collected, compost them with garden waste, raked leaves, and organic cafeteria waste (if appropriate).
- Use native plants in garden areas, as they tend to naturally resist insects, infections and fungus and can withstand local weather conditions such as extreme heat, cold or drought.
- Use organic pesticides and mulches.

- Irrigate higher grounds first to provide run-off to lower areas, use timers, and direct nozzles away from concrete areas.
- Reduce watering cycles when weather appropriate.
- Use rakes or blowers to remove leaves and debris from walkways instead of water hoses.
- Harvest and reuse rainwater whenever possible.

### 8) Energy Usage, Conservation, and Efficiency

Energy use is a key area where increased efficiency can result in significant cost savings. Energy savings can be achieved by simple changes in daily operations, maintenance practices, and employee habits. Most energy conservation efforts can be implemented at little or no cost. Although more significant energy savings may involve investment in new/upgraded equipment, these simple changes typically have excellent financial returns.

Examples of energy efficiency activities include:

- Conducting a facility-wide energy assessment.
- Submetering energy usage for detailed information on how and where energy is used within a facility and within processes.
- Maintaining equipment and the facility through an ongoing maintenance program.

### Maintenance Activities that Increase Energy Efficiency

<u>Furnaces</u>

- Analyze burners and flue gas; adjust fuel-air ratio
- Convert from atmospheric to oxygen burners
- Replace electric furnaces with natural gas or geothermal
- Improve or increase insulation on heating or cooling lines
- Improve thermodynamics by recapturing heat using condensers, regenerative heat exchangers, heat pumps, or similar equipment

<u>Process Heat Containment and Recovery</u>

- Enhance sensitivity of temperature control and cutoffs
- Use flue gas waste heat to preheat combustion air or process loads
- Insulate hot surfaces to reduce wall losses
- Use cogeneration of electricity and steam

- Use condensers, heat pumps, or regenerative heat exchanger to recapture heat

Process Cooling: Cooling Towers and Chillers/Refrigeration

- Use a cooling tower instead of refrigeration when outside temperature allows
- Use waste heat for absorption refrigeration
- Use variable-frequency drives (VFDs) on cooling tower fans
- Use higher efficiency chiller models
- Use highest temperature for chilling or cold storage
- Stage chillers to optimize part-load efficiency

Motors and Drives

- Upgrade existing motors to high efficiency motors; choose replacement motors with high power factor
- Use variable speed drives to control motor speeds
- Turn off idle motors
- Improve lubrication practices for motor-driven equipment
- Use energy-efficient power transfer belts and use notch belts instead of smooth belts to lower friction loss
- Measure and avoid / reduce motor vibration

Office Equipment

- When purchasing new equipment, buy higher-efficiency models with the U.S. EPA Energy Star label, and check the Energy Guide label included on many major appliances
- Put computers, printers, and other equipment into energy saver / sleep mode.

Compressed Air Systems

- Compressed air should only be used when essential
- Keep air hose lengths as short as possible to reduce pressure drops
- Keep air compressors at lowest possible pressure settings for demand requirements
- Check for and eliminate leaks in compressed air supply lines often
- Use outside air for intake when the weather is cold
- Recover heat or direct heat for heating space
- Use variable-frequency drives (VFDs) to control compressor if is not used at full load all the time
- Use more efficient air nozzle to reduce energy consumption

Heating, Ventilation, and Air Conditioning (HVAC) Equipment

- Develop an optimal start / stop schedule for the HVAC system
- Use a 7-day, programmable thermostat to coordinate system operations with loads
- Seal heating and cooling ducts
- Install a variable air volume system where practical
- Install an airside, rooftop, central, or waterside economizer to use outside air to cool the space
- Place cool air intakes and air-conditioning units in cool, shaded locations
- Be prudent on opening of overhead doors resulting in significant heat or cooling loss
- Replace old units with newer, energy-efficient units
- Change air filters regularly
- Use air curtains in shipping and receiving areas to reduce energy loss
- Reduce building ventilation air to minimum safe levels in areas unfrequented
- Install VFD on air handler motors

Electrical Power

- De-energize excess transformer capacity and increase power factor for facilities and equipment by installing the proper combination of fixed and variable capacitance
- Store heated / cooled water for use during peak demand periods
- Reschedule plant operations or reduce load to avoid peaks
- Use fossil fuel-powered generators during peak demand periods

Lighting

- Use LED lighting (lower energy consumption / increased life)
- Install low-mercury T-8 or similar triphosphor fluorescent systems with electronic ballasts
- Remove two out of four tubes in fluorescent fixtures where lower light levels are acceptable; disconnect the ballast that operates these tubes; install reflectors or higher output lamps so more light is utilized
- Install low-wattage, long-life, light-emitting, diode exit signs
- Use high-efficiency halogen, low-voltage halogen, and quartz lamps where lighting quality is critical (e.g., retail displays)
- Replace mercury vapor or other inefficient, high-intensity, discharge lighting systems with an efficient metal halide, sodium, or other high-output fluorescent systems

- Do not over-light areas; tailor lighting levels to the task and occupants, and increase the use of task lighting
- Rewire fixtures or use dimming controls to turn lighting off or down
- Install occupancy sensors in areas of sporadic use
- Turn off equipment and lights when not in use

Alternative Energy Usage

- Use solar heat for heating process
- Install wind powered electric generators
- Install a solar photovoltaic system to generate electricity
- Utilize water level difference by installing water turbines