

9 – Checklist

Checklist for a company audit

9.1 Substitution of materials

Non-toxic or less toxic alternatives are available for many materials commonly used in manufacturing. Their utilization reduces the environmental impacts of the waste generated and can cut waste disposal costs. Examine the materials processed in a company and try to:

- Eliminate toxic materials;
 - Reduce toxic materials;
 - Substitute them by less toxic materials or materials that can be re-used.
1. Can the company eliminate materials which are not essential to the process or quality?
 2. Can you use the same material or chemical for as many products and processes as possible to increase the potential for internal recycling?
 3. Can you use less hazardous materials as raw materials and cleaning agents?
 4. Can you replace hazardous materials by non-hazardous materials, for example, CFCs by other gases?
 5. Can you replace organic solvent-based inks, paints, coatings or cleaners by water-based products?
 6. Can you use pigments, catalysts, batteries and other products without heavy metals?
 7. Can you use non-halogenated instead of halogenated compounds?
 8. Can you find any other examples of replacing a polluting substance by a more environmentally friendly alternative within the company's operations?

9.2 Process change

A change in attitude can result in a considerable reduction of waste and cost savings. You can investigate a number of modifications to processes or equipment.

Redesign the product

1. Modify the product size and shape to reduce the quantity of materials used.
2. Redesign the product or change the materials used to generate less waste. Ensure that the waste can be reused or recycled, or that it is less environmentally harmful or expensive to dispose of.
3. Design the most economic way of cutting sheets and similar processes to minimize waste from off-cuts.
4. Reuse offcuts in the production process or recycle them if it is not possible to reuse them.

Improve awareness

1. Use the input/output approach to identify every point where waste is generated. Determine why it is generated and how it can be avoided.
2. Identify and repair all leaks in pipes, equipment and other systems.
3. Define loss control and housekeeping measures to minimize the amount of waste generated.

Redesign the workplaces

1. Redesign workplaces and processes to increase efficiency by storing materials closest to where they are used and minimizing the amount of handling or decanting between processes.
2. Use separate mixing or supply lines for products to reduce changeover clean-ups and downtimes.

Restructure the production process

1. Use automatic feed systems to minimize waste.
2. Optimize process control settings to minimize waste.
3. Change from batch to continuous production.
4. Collect remnants of the master batch to use for the next run.

5. Carefully plan colour and raw material changes (e.g. from lighter to darker) to minimize raw material losses.
6. Control overspray and drag-out to reduce evaporation losses and spills.
7. Allow for more drainage or drying time of products.
8. Plan the production sequence to equalize the generation of waste materials and reduce peak loads at treatment facilities.

Save on cleaning

1. Clean supply lines with a pig before flushing to capture more product and reduce the volume of cleaning waste.
2. Rinse or clean machines without additives to save costs.
3. Use alternative cleaning methods with maximum cleaning efficiency such as abrasives, high pressure sprays, water or steam.

Process changes

1. Change from wet to dry processes to reduce or eliminate waste.
2. Use mechanical instead of chemical processes.
3. Replace single pass processes by closed loop recycling.
4. Replace acidic or alkaline treatment processes by mechanical alternatives.

Reduce or eliminate solvents

1. Use water-based instead of solvent-based processes and systems.
2. Standardize solvents and cleaning agents to minimize the number of different products used – bulk buying of one product will be cheaper, too.
3. Replace solvent-based cleaning systems by mechanical or thermal alternatives such as air blast or dry stripping.
4. Minimize solids concentration in solvent waste for easier reuse.
5. Minimize solvent content in solid waste to make it less hazardous.
6. Recover spent solvent through distillation. In many cases solvents are mixed. Depending on the application, however, it is better to use only one solvent or to avoid mixing them.

Unmixed (clearly segregated) waste is a resource

1. Segregate waste at source in order to facilitate its reuse or recycling, to reduce the volume of waste requiring special treatment or to simplify treatment and disposal.

For example, you could separate:

- Hazardous from non-hazardous waste;
 - Recyclable from non-recyclable waste;
 - Organic (food/garden) waste from inorganic or metallic waste;
 - Highly toxic waste (such as cyanides) from the remaining waste;
 - Aqueous waste from flammables;
 - Chemical waste from general waste;
 - Halogenated from non-halogenated solvents;
 - Aliphatic from aromatic solvents;
 - Chlorine-fluorocarbons from methylene chloride.
2. Install ion exchange, ultra-filtration, reverse osmosis and electro-dialysis systems to separate waste stream components and return useful constituents to the production process for reuse.

Environmental upgrades

1. When you buy new equipment or replace old equipment, ask suppliers to provide information on environmental performance, for example, whether more efficient materials are available on the market or whether specific materials can be used to eliminate or minimize waste.

9.3. Containers and packaging

A company has a lot of options for minimizing container and packaging waste.

The suppliers

1. Ask suppliers to provide goods in reusable, returnable or refillable packaging, such as crates, drums, containers, pallets (consider available storage area) or in recyclable packaging.
2. Buy in bulk and distribute goods to various departments using waste cardboard boxes.
3. Buy the same product from one supplier to reduce the amount and variety of packaging material.
4. Ask suppliers to use machines to wrap plastics around boxes and pallets rather than manual wrapping in order to reduce the amount of plastics used.
5. Ask the suppliers for information on new products, new ways of using existing products and new processes to reduce environmental impacts.
6. Avoid over-packaged products or ask the supplier to reduce the amount of packaging.
7. Request reusable or recyclable containers from suppliers or ask them to take back their containers or packaging.

The products

1. Minimize packaging of the manufactured products, for example by packing loose or in bulk.
2. Use returnable, refillable or reusable containers and packaging.
3. Ensure that containers and packaging of the manufactured products are recyclable.
4. Use single material packaging where possible – it is easier for the customers to recycle.
5. Use vacuum packaging.
6. Shred non-recyclable paper items for use as packaging material.
7. Separate packaging waste for recycling (paper, plastics, glass, steel straps).

The customers

1. Include a message on containers and packaging encouraging the customers to reuse or recycle them.
2. Offer the customers a take-back service for containers or packaging so that you can reuse or recycle them.

9.4 Saving water

Measure water consumption

1. Install water meters to measure water consumption in key activity or process areas. Compare the results with readings carried out by the water supplier to ensure that no large unexplained losses have occurred.
2. Monitor water consumption for each process to identify opportunities for savings, to quantify flow-rate reductions and calculate possible water and cost savings.
3. Investigate any unexplained increases in water consumption.

Eliminate unnecessary water consumption

1. Where possible sweep using brooms, mops and scrapers to clean floors, pools or outside areas rather than hosing them down.
2. Pre-clean equipment or surfaces with a broom or vacuum cleaner before hosing them down.
3. Use non-water-based cleaning systems such as vacuums.

Reduce water consumption

1. Educate staff about minimizing waste by turning taps and hoses off after use.
2. Make it easy for staff to reduce water consumption by putting shut-off valves on hoses so that they do not have to walk to the tap.
3. Use spray-adjustable nozzles on hoses and taps.
4. Use process controls or timers to restrict water flow rates, including:
 - Installing photosensors in spray-rinse chambers;
 - Repairing or replacing defective photosensors, process controls or timers;
 - Performing routine maintenance (clean and readjust).
5. Use water flow restrictors for flowing rinses and all water consuming processes.
6. Halve the toilet flushing water by:
 - Installing flush controls so that toilets stop flushing when the hand is removed;
 - Installing dual-flush or low-flush toilets;
 - Reducing the toilet flush capacity by placing a "brick" in the cistern.
7. Modify urinals to flush only on demand and replace urinals by low-flush toilets in new buildings.
8. Use low-volume shower hoses and taps.

Maintenance

1. Regularly inspect taps, toilets, showers, all visible pipework, all valves and plant rooms for leaks and running water.
2. Set up a system that makes it easy for staff to report leaks promptly.
3. Repair leaks as soon as after they are reported.

Efficient use of water

1. Use an appropriate ratio of water to cleaning agent and minimize the consumption of cleaning agents as far as possible.
2. Use an appropriate ratio of water to materials to be diluted or mixed in order to minimize the water and material consumption as far as possible and provide staff with correctly sized containers or calibrated dispensers.
3. Increase rinsing efficiency while reducing waste by using the following technologies:
 - Counter-flow rinsing;
 - Spray rinsing;
 - Fog nozzles;
 - Reactive rinsing;
 - Agitation to ensure adequate rinsing rather than consuming more water.
4. Maintain and optimize plumbing and other equipment used for directing the water flow through the production facility by improving water spray cabinet sumps and immersion baths to maximize the water rinsing capacities.

Reuse of water

1. Sequence the process operations so that wastewater from one process can be used for another.
2. Reuse cooling water for other purposes.
3. Filter and reuse cleaning or process water.
4. Treat and reuse spent rinsing or process water by recovery techniques.

Water consumption in the canteen and laundry

1. Install water efficient appliances such as dishwashers and rinsing taps and
 - Operate dishwashers only when full;
 - Use appropriately sized dishwashers for the number of dishes generated by the company;
 - Do not defrost or clean food under running water;
 - Produce ice in the most effective sizes and amounts.
2. Install small, regular and high-load washing settings in the laundry and
 - Use optimal washing options for different loads (include one small machine for urgent laundry);
 - Ensure that machines are equipped with low, medium and high water consumption settings.

Outdoor water consumption

1. Use alternative water sources for irrigation, such as rainwater, recycled wastewater from buildings or cooling water.
2. In gardens:
 - Use native rather than exotic plants to reduce the consumption of water and chemicals.
 - Control irrigation using timers, soil humidity sensors (to determine whether irrigation is necessary) and rainwater sensors to stop or reduce irrigation as appropriate.
 - Install sub-surface irrigation systems fed by wastewater or rainwater.
 - Investigate mulching to prevent weed growth and reduce evaporation.
 - Irrigate at night or in the evening to reduce transpiration water losses by evaporation through leaves.

9.5 Saving energy

Does the plant have any of the following equipment, machines or systems?

Equipment/machines/systems used to support manufacturing, such as:

- Steam and hot water systems including boilers;
- Electrical/lighting systems, such as electronic motors, transformers, pumps, building lights and electric heaters;
- Air or ventilation systems including fans;
- Refrigeration/process cooling/compressed-air systems;
- Cleaning or washing systems.

Equipment/machines/systems directly used in the manufacturing process:

- Processing tanks such as reactors and vats;
- Size reduction equipment such as metal or cloth cutting machines;
- Fluid-flow or pneumatic conveyance systems.

If you have answered “Yes” to any of the above questions, then you could investigate the process or equipment modifications suggested below.

Start with the basics:

- Turn off lights, heaters, air conditioning and equipment when not in use;
- Do not use equipment/machines when not required, for example lights with windows;
- Use insulation and ventilation instead of heating and cooling;
- Install energy-efficient lighting and other equipment;
- Maintain equipment at optimum efficiency;
- Post signs and educate staff.

You will be surprised by how much money these simple measures will save!

Measure energy consumption

1. Ask the electricity supplier to provide energy data on a regular basis. Ask to how much detail they can break down the energy consumed by the company (some companies will provide charts of energy consumption at 30 minute intervals).
2. Install submeters to measure energy consumption in key activity or process areas.
3. Monitor energy consumption in each process or area to identify the saving potential, quantify reductions and calculate the energy and costs saved. The energy supplier will be able to provide some helpful advice.
4. Investigate any unexplained increases in energy consumption.

Eliminate unnecessary energy consumption

Do not draw power at night, weekends or during breaks when nobody is in the company.

- Turn off lights, photocopiers, computers, heaters, air conditioning and other equipment and machinery when not in use;
- Do not use equipment/machines when not required, for example lights with windows;
- Use insulation and ventilation instead of heating and cooling.

Reduce energy consumption

1. Use equipment such as printers and copiers with a sleep mode function.
2. Install timer controls to prevent machines being left on after working hours.
3. Incorporate a “lights-off check” into off-shift security inspections.
4. Carry out energy awareness campaigns (especially relating to “Turn it off”) on a regular basis.
5. Install energy-efficient lighting systems, including:
 - Efficient reflectors;
 - Energy-efficient bulbs or tubes;
 - Replace incandescent lamps in exterior fittings by compact fluorescent lamps;
 - Effective but not superfluous lighting levels;
 - Modular lighting controls to light small areas.

6. Check whether:
 - Average lighting levels comply with codes or special requirements and remove fittings or delamp fittings where levels are higher than necessary;
 - Redundant circuits can be disconnected where delamping has been carried out;
 - Light switches can be relocated to more convenient positions.
7. Investigate installing:
 - Occupancy sensors for lighting store rooms, basements and other places where there are multiple entrances and variable occupancy rates;
 - Daylight sensors for rooms and areas with good daylight and adjustable lighting levels;
 - Extra lighting controls so that smaller areas can be lit individually.

Maintenance

1. Set up inspection and maintenance schedules to ensure that:
 - Water heating systems are maintained at optimum efficiency;
 - Energy-efficient heating and cooling systems are installed and maintained at optimum performance levels.
2. Have you ensured that:
 - Defects are promptly reported and repaired?
 - The performance of the equipment is monitored?
 - Available electricity prices are annually assessed?
 - Equipment for replacement is selected on the basis of capital investment, operating costs, labour costs, reliability, maintenance costs and running costs?
3. Regularly check for and seal all thermal and mechanical leaks in the system. It is easier to find compressor leaks outside operating hours when all the machinery is switched off. The noise indicates the size of the leak, for example, from:
 - Compressed-air leaks;
 - Heat loss due to poor insulation.

4. Regularly carry out inspections to ensure that process conditions, particularly the temperatures and pressures in the equipment are as close to the manufacturer's specifications as practicable and that no equipment is over-heated or maintained at a higher pressure than recommended by the manufacturer.
5. Operate compressors at the lowest possible pressure. A compressor operating at 7 bar uses 15% more electricity than one operating at 5 bar.

Efficient use of energy

1. Have you carried out a cost-benefit analysis to determine the optimum time and market conditions to replace older equipment?
2. Investigate and reduce heat losses in buildings:
 - Have you minimized infiltration and heat losses by checking that:
 - Doors and windows seal properly;
 - Building fabric is in good condition;
 - Ventilation functions optimally?
 - Have you determined if it is practical to physically separate heated from non-heated areas using insulation material, fast closing doors and air locks?
 - Have you insulated ceiling/roof spaces? Older buildings and spaces above and around hot water cylinders and heaters/radiators can especially benefit from insulation.
 - Have you re-evaluated space needs to ensure that you are not heating buildings or sections of buildings that are not frequently used or in a poor state of repair?
 - Have you inspected and repaired existing ceiling/roof insulation and repaired any areas that were damaged by water?
3. Investigate and reduce energy consumption for heating.
 - Have you scrutinized areas where supplementary electric heating is used (such as portable fan heaters)?
 - Have you repaired or extended the main heating system or provided controllable electric heating?
 - Have you ensured that fan coil heaters are isolated from heat and electricity outside the heating season?

- Have you insulated and do you regularly maintain insulation on all pipes (hot water, steam and condensate), flanges, valves, etc.?
- Have you removed or blanked off all redundant piping and dead legs?
- Have you checked and do you regularly maintain all joints, glands and valves for leaks?
- Have you ensured that the water pumping rate is correct throughout the heating system?
- Have you determined whether reducing valves, steam traps or by-passes are correctly installed and have drain points, air vents and strainer protection where appropriate?
- Investigate whether the installation of power factor correction equipment will reduce electrical system losses.

Efficient air and ventilation systems

1. Can you use natural instead of mechanical ventilation? Roof vents with pneumatic or electric dampers can be used to encourage natural ventilation in the summer.
2. Have you examined existing operating times and requirements in detail? Often systems are left switched on because it has always been the practice and nobody knows where the switch is!
3. Have you determined the extent of local exhaust ventilation systems and modified systems to only extract air where required?
4. Have you adjusted ventilation systems and controlled extraction volumes to actual needs?
5. Can you use speed control in fans and motors to control air flows rather than installing more dampers in the system?
6. Can you use timers and demand control to prevent machinery from running when not required? Occupancy detection can be used in toilet and storage areas, although it is important that the health and safety of the people present in the rooms is not compromised.
7. Can you use a heat exchanger to transfer energy from heated exhaust air to inlet air while avoiding re-injection of exhaust air into inlet grilles?
8. Do you carry out filter maintenance as prescribed and keep records? If manometers are not fitted, install cleaning diffusers and return grills and extract grills regularly. Note areas where dirt or loose materials build up.

Efficient boilers and efficient use of hot water

1. Ensure that boilers are correctly sequenced and that they are at maximum possible capacity.
 - Can one boiler operate at high capacity rather than two boilers at moderate capacity?
 - Is there a demand for heating or control air outside working hours? If so, is it more cost-effective to install additional low-capacity equipment, e.g. electric heater, low-pressure compressor, and to switch off the main equipment?
2. Do you maintain the highest possible temperature in the feed water tank in order to maximize the boiler capacity? If the heat required by the system is close to the maximum output of a single boiler do you need a second boiler?
3. Can you maximize the use of waste heat from contaminated condensate, high-temperature discharges to effluent, boiler blowdown and flash steam for pre-heating feed water?
4. Have you covered and insulated the feed water tanks and hot water supply lines?
5. Can you use smaller, on-demand hot water heating systems at the point of use, instead of a large centralized supply?
6. Have you determined the most appropriate chemical dosing system for the feed water and the boiler operation?
7. Check heating in process treatment tanks.
 - Have you used covers where possible to minimize the evaporative loss from process tanks? Covers can reduce heat consumption by over 50% when compared to bare tanks.
 - Have you ensured that the air extraction rate above tanks is the minimal required rate? High extraction rates can result in high heat loads.
 - Have you investigated reusing condensate from process heating coils? It is now possible to design systems which detect the contamination of the condensate, thereby allowing condensate to be returned and disposing of contaminated condensate.

Efficient motors

1. Carry out performance tests on larger motors. It is common for fan motors and pump motors to be oversized and therefore to operate very inefficiently.
2. Fit variable speed controls or soft start controls with energy reduction features:
 - If motors are oversized; and/or
 - If the load on the motor varies.
3. Replace existing motors with increased energy consumption by high-efficiency motors if they are:
 - Oversized;
 - Large;
 - Operating for long periods; or
 - After a breakdown or damage.

Efficient compressed-air systems

1. Is compressed air really required for the operation? It can often be replaced by electricity requiring less than a tenth of operational costs compared to compressed air.
2. Is the air inlet of the compressor situated in a cool area? Every extra 4 °C rise in temperature increases electricity costs by 1%.
3. Do you need control air (2 bar) outside working hours? If so, it is more cost-effective to install an additional low-pressure air compressor and shut off the main air compressor.
4. Can you shut off sections of the distribution network when not required, for example at weekends?
5. Are there adequate drain points in the system and are these opened automatically or can a manual system provide better control? Air receivers need regular draining because a receiver full of water will cause the compressor to cycle between load and no-load more frequently than necessary. This could result in cycling problems or overheating of the electrical starters, and in addition running off-load still uses electricity.

Cost-effective load management

1. Avoid unnecessary duplication of equipment or machinery, for example, using two boilers where one could handle the load at full capacity.
2. Ensure that the load in the system is evenly distributed to eliminate the need for extra equipment.
 - Can you use timer controls or other measures to eliminate peaks in heat demand which require additional boilers?
 - Can you shift loads to night-time in order to benefit from special electricity rates and reduce the maximum system capacity required?
3. Ensure that capacities and demands are matched. This applies particularly to boilers, transformers, compressors, motors and fans. In particular:
 - Ensure that equipment or process systems are not oversized or under-utilised;
 - Match the size of the equipment to actual requirements to reduce standing losses and connection charges.

Investigate the use of waste and renewable energy

1. Have you investigated co-generation of heat and electricity, for example, if large boilers are replaced and the heat demand is constant throughout the year?
2. Can you use heat exchangers or waste heat for heating?
3. Have you investigated the use of renewable energy sources such as solar or wind energy?

9.6 Office, canteen and washrooms

Do not forget these areas. Their activities also have environmental impacts and the cost of materials, water and energy can be reduced.

1. Office: Check the following:

- Energy consumption and efficiency;
- Materials used: reduction, reuse, recycling;
- Purchase of recycled materials.

2. Canteen: Check the following:

- Energy consumption and efficiency;
- Water consumption and efficiency;
- Materials used: reduction, reuse, recycling;
- Purchase of recycled materials (e.g. napkins);
- Composting of organic waste;

3. Washrooms: Check the following in toilets and showers:

- Energy consumption and efficiency;
- Water consumption and efficiency;
- Materials used: reduction, reuse, recycling;
- Purchase of recycled materials.