

9 – Background Material

9 Textbook – Audits

9.1 What is a cleaner production audit?

**“Audio”
means “to listen”**

The word “audit” is derived from the Latin word “audio”, which means to listen or to question. Today it refers to the verification of the accounts of a company, to the analysis of a management system or, in our case, to the determination of cleaner production options for a company.

A cleaner production audit is often the first step towards managing, controlling and improving the environmental performance of a company. If a company was not previously concerned about the environmental impacts of its production, an audit is the best way to establish the actual status and determine the best approach to reducing waste, wastewater and emissions.

During the audit the handling of materials and operation of machines is also examined. This is where occupational health and safety comes in, i.e. characteristics of materials used, materials handling and personal protection of the operators is checked.

The link to quality management is obvious: In order to increase product quality defective products are analysed. The reasons for defects are determined and approaches for the minimization of nonconforming products are identified.

A cleaner production audit provides an overview of those areas of a company's operations which are subject to environmental legislation or which may become a liability in future. In addition, areas where cost-effective environmental improvements can be achieved are highlighted.

**A cleaner
production audit
helps to identify
low hanging fruits**

This manual presents a method which can be used as a quick scan at the beginning of a cleaner production project to:

- Identify “low hanging fruits” in view of generating immediate savings and motivating the project team;
- Check health and safety related deficiencies;
- Identify risks to the quality of products;
- Set priorities for the project.

9.2 Conducting a cleaner production audit

9.2.1 Objectives of a cleaner production audit

The objectives of a cleaner production audit are:

- Reducing waste and emissions;
- Saving materials, energy and water;
- Minimizing safety and health risks;
- Improving quality by minimizing off-specification products;
- Reducing environmental impacts;
- Reducing operational costs.

Objectives of a cleaner production audit

A cleaner production audit is a method of identifying the inefficient use of resources and the inadequate management of waste by focusing on environmental aspects and thus determining the impact of industrial processes.

Many organizations have produced more or less detailed manuals describing methods for the assessment of cleaner production. The underlying strategies, however; are similar. The basic concept can be summarized as a review of a company and its production processes in order to identify areas where resource consumption, hazardous materials and waste generation can be reduced.

This chapter describes the procedure for conducting a cleaner production audit in a condensed version, which consists of three steps. It focuses on the actual observation of current practices and on the identification of opportunities for improvement. This audit method can be employed at the start of a cleaner production project with a company to identify low hanging fruits and to set priorities.

9.2.2 Overview of the steps

Step 1: Prepare	<ol style="list-style-type: none"> 1. Define responsibilities 2. Define the scope 3. Collect documents for preliminary information 4. Develop a schedule 5. Prepare checklists and inform staff
Step 2: Carry out	<ol style="list-style-type: none"> 1. Audit 2. Evaluate the findings 3. Organize a wrap-up meeting
Step 3: Follow-up	<ol style="list-style-type: none"> 1. Follow-up on corrective action 2. Report to management 3. Document and report

9.2.3 Step 1: PREPARE

9.2.3.1 Define responsibilities

Key features of an auditor

Ensure that the people who will carry out the cleaner production audit are qualified and properly trained. The auditors or audit team must have experience in the particular field of activity of the audit scope, as well as knowledge of cleaner production, best available technology, best practices, organizational aspects, the environment, and the environmental requirements for the specific area. In addition, they should be familiar with occupational health and quality management, if the scope of the audit includes these aspects.

The cleaner production auditors should not be directly involved with the area of the company in which they will carry out the audit. Since one person cannot be expected to fulfil all these requirements, an audit team is usually set up comprising members that can meet all these requirements.

A suitable cleaner production audit team should consist of one or two cleaner production experts and a group from the company comprising the environmental representative and the environmental team.

The ideal auditor has a number of key qualifications:

- Diplomacy;
- Ability to listen and good communication skills;
- Attention to detail;
- Flexibility in adapting to the company's culture;
- Authority, acceptance and support within the organization;
- Access to expert knowledge of relevant laws, regulations, codes and organizational standards;
- Access to staff or advisors who are able to convert legal and other obligations into everyday organizational procedures;
- Access to all levels of the organization, as required;
- Access to senior decision makers.

The auditor should play an active role

Some internal auditors may not see their task in these terms, instead they will possibly prefer a more passive "reporting" role. However, as the main point of an audit is to learn together and initiate change, the cleaner production auditor should play a stimulating and active part in order to identify unnecessary waste, question existing practices and stimulate new and better solutions.

9.2.3.2 Define the scope

The scope of the audit

Make sure the auditors or audit team are duly informed about the physical area to be audited. Refer to the existing maps of the site.

Decide how the audit will be organized, e.g.:

- According to production processes, e.g. cutting, assembling, painting and drying;
- According to areas of work, e.g. delivery, production, packaging, dispatch;
- According to business areas, e.g. purchasing, production, facilities, personnel;
- According to production schedule to ensure that the auditors can observe the actual processes in full operation.

Follow the production flow

The most effective way is to organize the audit by following the production flow: Starting with the delivery of the raw materials and their storage, the actual production processes and finally analysis of packaging, storage and dispatch of the products.

The auditors or audit team should check whether:

- Material is properly stored;
- Dosage recipes are observed;
- Chemicals are properly handled (avoiding spills and other handling losses, there are adequate emergency measures in case of accidents);
- The principles of good housekeeping are understood and followed;
- Personal protective equipment is worn by the operators where appropriate;
- Workplaces are:
 - Ergonomic;
 - Well-lit;
 - Not exposed to excessive smell, dust or noise;
 - Not exposed to sources of excessive heat or cold;
 - Not exposed to mechanical risks;
 - Not exposed to concentrations of chemicals exceeding legal limits;
- The workplaces are clean and tidy;
- Machines are well maintained;
- Controls are working properly;
- Waste is segregated;

- Existing rules and procedures are documented and are complied with;
- Employees understand their role regarding the environmental policy;
- The consumption of materials, water and energy is documented;
- Data on materials consumption is documented, checked for consistency and used for specifying of indicators;
- Indicators are used for feedback.

For details regarding the following items refer to the relevant **checklists**:

Consult the specific checklists

- Water consumption;
- Compressed air;
- Lighting;
- Steam system;
- Cooling system.

At this stage the audit does not include all the formal elements of an initial audit or an internal audit required for an environmental management system according to ISO 14001. Such audits include in addition:

- Organizational aspects: Are the regulations of the management system followed, is the necessary documentation maintained, are the regulations sufficient to ensure the implementation of the environmental policy, the evaluation of environmental aspects, the control of key processes affecting the environmental performance, the training of employees, corrective measures and risk prevention?
- Legal aspects: Does the company comply with existing legal regulations, is there a register of legal obligations, is it maintained?

**Good preparation
is important**

9.2.3.3 Collect documents for preliminary information

Several documents will help you to understand a company's policy, its products and the key characteristics of its production process. These include:

- Company policy or environmental policy, if existing;
- Company web page;
- Promotion material;
- Quality and/or environmental manuals;
- Plant maps;
- Emergency and evacuation plans;
- Test and maintenance records;
- Organizational chart;
- Contracts (energy, water);
- Other manuals;
- Material safety data sheets.

These documents should be collected in advance and studied during the preparation of the audit.

9.2.3.4 Develop a schedule

The auditors should prepare an audit plan providing enough time to:

- Talk to management;
- Conduct an on-site visit;
- Evaluate the observations;
- Formulate recommendations;
- Write a report.

The audit team should have the experience required for auditing the given area, while at the same time their independence needs to be ensured, i.e. they should not directly report to the person in charge of the department. The audit plan should cover all relevant areas of production. A proper timeframe should be set, to allow for enough time to thoroughly study the actual practice at the plant, technical installations and talk to the operators about problems and opportunities for improvement.

9.2.3.5 Prepare checklists and inform staff

The audit team should prepare checklists for each area to be audited. Samples of checklists are included in the Checklists section of this volume. The employees of the area to be audited should be informed about the audit plans.

9.2.4 Step 2: CARRY OUT

9.2.4.1 Audit

The audit is carried out based on the checklists defined through observation and interviews with employees. During this phase it is very important to ask the right questions in order to understand the actual procedures and collect initial data as well as initial opportunities for improvement.

Opening meeting

If the audit is carried out in a large company, a formal introductory meeting should be organized. In a smaller business the auditors may already be acquainted with the staff and therefore an introductory meeting is less important.

The overall objectives of the introductory meeting are:

- Introducing the team of auditors to the representatives of the audited company;
- Discussing the objectives and scope of the audit;
- Presenting the methods to be used during the audit;
- Discussing and adapting the audit plan;
- Discussing organizational matters (guides, resources, safety equipment, rooms, locks, etc.)
- Fixing a date and time for the wrap-up meeting;
- Presenting checklists and forms which will be used during the audit.

During the audit the way you ask questions is important. There are basically three categories of questions used in an audit:

How to ask questions

- Open questions;
- Closed questions;
- "Mirror questions".

Open questions start with "who", "what", "when", "how", "where", etc. They invite an explanation and are well suited for collecting information. Examples of open questions are:

How do you control the water flow in this machine?

How many bags of this chemical do you use every day?

Closed questions start with "do". In principle they can only be answered by "yes" or "no". These questions are less suited for learning in a cleaner production audit, because they do not invite communication. Examples are:

Do you have an environmental policy?

Do you use recipes for the dosage of chemicals?

“Mirror” questions are used to establish a common basis between the auditor and the auditee. They usually refer to a statement made by an employee of the audited company, for example:

Did I understand correctly that you measure pH and temperature twice a day?

If I understand correctly this insulation was removed during the last repair work and should be fixed again soon?

Mirror questions avoid misunderstandings and improve the climate of the conversation.

The description of the processes performed in a company should answer the following questions:

**Process
description**

- What does the company manufacture?
- What is the company’s history?
- How is the company organized?
- What are the main processes?
- What are the most important inputs and outputs?
- What is the company’s strategy for the future?

Draw flowcharts

Processes can be represented in a detailed process flow chart specifying input, output and environmental problems of each production step. Drawing flow charts represents a key step in the audit, and forms the basis for material and energy balances which are established later in the assessment. The process flow charts of an environmental audit should focus on activities which are often neglected in traditional process flow charts, such as:

- Cleaning;
- Storage and handling of materials;
- Auxiliary operations (cooling, steam and compressed air);
- Maintenance and repair of equipment;
- Materials that are not easily recognizable in output streams (catalysts, lubricants);
- By-products released to the environment as fugitive emissions.

The process flow chart provides an overview and should be supplemented by individual input/output sheets for each operational unit or department.

**Inspecting the
company**

A great deal of information may be gathered during a walk-through inspection of the company. If possible, the inspection should follow the process from start to end, focusing on areas where products, waste and emissions are generated. The objective of the inspection is to identify inefficiencies in resource consumption and quality as well as unnecessary risks to health and safety.

During the inspection it is important to talk to the operators, since they often have ideas or information that can be useful for identifying sources of waste and cleaner production opportunities. Your findings should be based on actual observations. Look for evidence! For example, when checking if the required fire extinguisher is placed in front of a storage room containing solvents, ask the person in charge to show you the device, ask him to explain its handling and check whether the sticker of the servicing company indicates that it is regularly serviced.

Questions to be asked include:

- Are there any signs of poor housekeeping, i.e. untidy or obstructed areas of work, etc.?
- Are there any noticeable spills or leaks? Is there any evidence of past spills, such as discolorations or corrosion on walls, work surfaces, ceilings, walls or pipes?
- Are there any open containers, broken bags, piled-up drums or other indicators of poor storage procedures?
- Are water taps dripping or left running?
- Are there any signs of smoke, dirt or fumes to indicate material losses?
- Are there any strange odours or emissions that irritate the eyes, nose or throat?
- Is the noise level high?
- Are all containers labelled indicating their contents and hazards?
- Is emergency equipment, e.g. fire extinguishers and absorbent, available and visible to ensure rapid response in case of a fire, spill or other incident?
- Is the fire-fighting equipment well maintained and checked (once a year)?
- Is the required safety equipment used by the operators, e.g. goggles, gloves, aprons in case of work with acids and caustics, safety shoes in case of manipulation of heavy loads, adequate work clothes, noise protection?
- Have you noticed any waste and emissions being generated from process equipment e.g. dripping water, steam, evaporation?
- Do employees comment on the sources of waste and emissions in the company?
- Are the employees trained and do they understand the processes they execute?
- Which documents are in use? Is data on actual material consumption collected, evaluated and used as a basis for controlling and increasing efficiency?

- Are there clear work instructions for important process steps, e.g. tuning machines, key process parameters and procedure in case of machine failures?
- Are there any meters for electrical energy or water, and are they regularly read and the readings analysed?

Crosscheck data

Sampling, in essence, is the process of learning a lot by looking at a little. Sampling is thus just another tool the auditor uses to form his opinion.

The samples and corresponding results are merely raw data which has to be scrutinised and sorted. It must be analysed in view of defining its content, and possible causes and effects. Samples are only the first step on the road to an informed audit opinion.

Data from different sources should be used for crosschecking. Ideally we can find the same material or energy flow three times in a company: as input, inside the area where it is used, and as output. This data should be correlated and checked for consistency.

During the inspection, problems encountered along the way should be listed and if any obvious solutions arise, they should be recorded immediately. Special attention should be paid to no-cost and low-cost solutions which should be implemented immediately, without a detailed feasibility analysis. The audit team should also pay attention to health and safety risks.

Take pictures during the inspection

Taking pictures during a cleaner production audit is a good way of documenting observations. However, it is advisable to ask for permission first, because there might be areas in the company where taking pictures is not allowed for various reasons.

Relate observations to best practice**9.2.4.2 Evaluate the findings**

Based on observations made, the audit team can decide whether non-conformity should be dealt with immediately or included in the audit report.

Observations made should also be compared to best practices and best available technology, and their application in that particular context should be considered. The goal is to learn together and critically assess the potential for optimization.

9.2.4.3 Organize a wrap-up meeting

The observations and findings of the audit team should be examined together with the manager of the audited area (minutes of this meeting should be taken). The necessary corrective action is agreed upon in this meeting and is then outlined in a report.

9.2.5 Step 3: FOLLOW-UP

9.2.5.1 Follow-up on corrective actions

**Use a programme
to follow up on
your findings**

Follow up on any corrective action agreed upon after the audit. For this purpose it is recommended to draw up an action programme, either during the wrap-up meeting or after presentation of the audit report. The action programme should define exactly, the responsibilities for the identified measures and the corresponding resources. The programme is then used for follow-up by management.

9.2.5.2 Report to management

An overall environmental audit report with conclusions covering the entire company should be prepared and presented to management within three weeks.

9.2.5.3 Document and report

The audit report should include the following items:

- Description of the site visited;
- Summary of the purpose of the audit;
- Summary of the questions asked;
- Summary and interpretation of the answers;
- Flowcharts;
- Description of the material flows observed;
- Observations regarding waste and emissions;
- Observations regarding good housekeeping practices and storage;
- Observations regarding occupational health and safety;
- Observations regarding the improvement of product quality;
- Key data and indicators for benchmarking;
- Recommendations;
- Opportunities for improvement;
- Programme for future action.

Convincing audit-reporting documents are more likely to initiate management action. To write effective audit reports, it is important to:

- Understand the users and readers of audit-reporting documents;
- Use the five elements of observation: condition, criteria, cause, effect and recommendation;
- Revise the report for logic, clarity, impact, tone, conciseness and readability;
- Use current audit reporting trends, including collaborative and consultative reporting styles;
- Clearly highlight cost saving potentials;
- Clearly address risks and liabilities.

9.3 Psychological aspects of auditing

9.3.1 The two dimensions of an audit

The iceberg, shown below, is a convenient metaphor to describe the audit process. The tip of the iceberg represents the technical dimension of the audit. Being “above the water line”, the technical dimension includes the most visible and objective aspects of an audit. The way the audit is planned, the operations audited, auditees interviewed, etc.

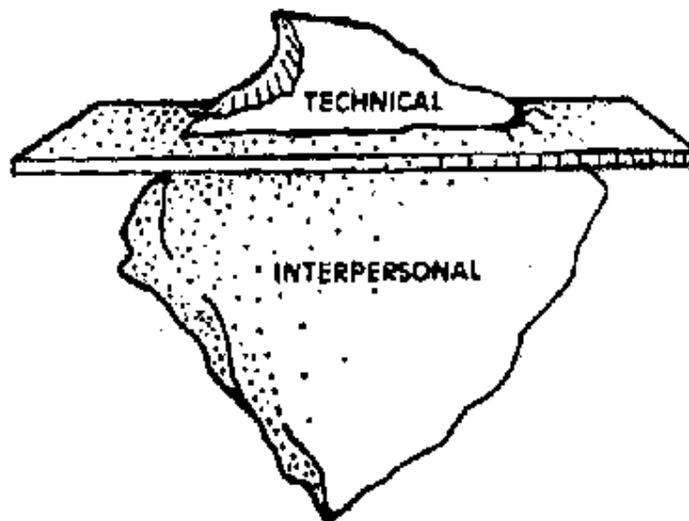


Figure 1: The iceberg of the audit process

As with an iceberg, however, a significant part of the audit takes place “below the water line”. This is the interpersonal dimension, i.e. the manner in which the audit is performed and what the auditees feel about the audit.

The interpersonal side of an audit has a direct impact on the technical quality of an audit. For example, the technical task of asking questions to obtain audit information is quite straightforward. Yet, the interpersonal side of how questions are asked directly influences the quality of the information obtained. Unless you pay equal attention to both the technical and interpersonal dimensions of an audit, it is unlikely that the audit will be uniformly effective.

9.4 Advice for auditees

So You're Going To Be AUDITED! We have included a brief guide on how to act as an auditee for all potential audited persons and/or companies.

Be prepared for the audit

Before the audit, try to collect information on process requirements and understand the scope of the audit. Review and be familiar with procedures and work instructions in your area. Familiarize yourself with the audit plan and find out when your involvement may be required. Be prepared for auditors asking you questions about your job as well as about the procedures and working instructions that you use. Ensure that you know the location of documents relevant to the audit, including quality records.

Listen, listen, listen!

Listen to a question completely before answering it. Do not avoid questions, answer directly. Be open and honest. Do not try to hide any information. Guide the auditors only to those locations they wish to see. If there is a choice of locations to visit, choose one that is operational and the best that you have to offer. Act professionally. Never argue with the auditor. Do not get emotional over observations of non-conformities in your area. Get help if you need it! Find the most competent person available for a certain area of expertise. Do not guess responses, try to find someone who can provide the answer. Ask supervisors or team leaders for assistance.

Typical questions you have to expect are:

Typical audit questions

- Could you please explain your work?
- How do you know what you are supposed to do?
- Are there any work instructions defining how you perform your work?
- What records do you keep, where and for how long do you keep them?
- Do you know if the company has an environmental policy?
- Can you tell me what this policy means for your work?
- Which processes do you use? How do you measure the effectiveness of the processes?

Before answering questions think for a moment. Never pretend to know the answer, do not try to bluff the auditor. If the auditor finds a non-conformity in your area and you do not agree with him/her, do not argue. If you have good reason to believe that they have not examined all the facts, allow the audit team to take further action.



When describing your work, be positive about it because it is your process and you know that it works! You have worked on, and with your processes. The audit is the appropriate time to show how much you have done and how well you have done it. Enjoy the opportunity to demonstrate your professionalism.

If possible, correct minor non-conformities before the final meeting of the audit, in this way you demonstrate your intention to comply with the requirements.

9.5 Cleaner production audit, initial review and auditing in an environmental management system

If you consider establishing an environmental management system, a procedure should be developed describing how future audits are to be initiated and implemented. Furthermore the audit plan has to include all areas of the company, as well as the entire organization (e.g. several production sites).

The forms and reports relating to previously implemented environmental audits should be kept by the environmental manager. They can be used by management for reviewing the EMS and by an external verification body that checks or validates the management system.

If you carry out internal audits regularly as part of a quality management system, consider whether you can use existing procedures. It is easy to integrate an environmental audit into the procedure for internal audits carried out in the framework of a quality management system.

Remember that the documents developed for the audit can be used as part of the overall documentation for the EMS. It should be possible to reuse and update them.

9.5.1 Integrated management systems

An **integrated management system** combines separate management systems, e. g. according to ISO 9001, ISO 14001, EMAS or with regard to occupational health. Although quality, environmental as well as health and safety management systems originate from different aspects of the company's performance, they have a number of characteristics in common. They require systematic planning, implementation, control, auditing and improvement. By integrating these different systems, synergetic effects can be achieved and inconsistencies and overlaps can be avoided. The integration of existing elements reduces the time required to develop new systems and increases acceptance by employees.

Integration is more than simply adding up the elements of systems established by different experts. A truly integrated management system takes the core processes of the company as a starting point and develops consistent procedures in order to optimize these core processes.

Cleaner production methods analyse and discuss the production processes in great detail in order to reduce the use of chemicals, minimize waste and emissions, and raise awareness of the workforce and management to environmental questions. Especially in small companies this approach often results in immediate and visible improvements with regard to occupational health, quality and environmental performance.

In many companies quality management, health and safety management as well as environmental management are organized as three parallel systems. This separation is often confusing for employees who have to work with different systems at the same time. It is of no relevance to the employees whether special requirements for their working processes are defined by the quality manager, the safety manager or the environmental manager. They are mainly concerned with the tasks resulting from these requirements and where and how they can obtain the necessary information. In order to support the employees in their tasks the management system needs to describe the requirements consistently and focus on actual processes.

Quality, health and safety aspects as well as environmental concerns should not be separated as they are integrally linked at the workplaces from the employees' point of view. Their daily work not only includes the correct handling of plants, but also the safe management of hazardous materials and the disposal of waste. Quality management, environmental management and health and safety are thus different aspects of the same organization. Efficient systems are designed so as to fulfil the requirements of international standards such as ISO 9001 or ISO 14001.

Additional information on the inclusion of cleaner production in environmental management systems is provided in Volume 11 of the Toolkit

9.6 Reporting

Reports are an important part of auditing and management systems. In order to document CP activities various report formats are proposed in different manuals or papers. Volume 9 of the UNIDO Cleaner Production Toolkit includes the UNIDO endorsed Cleaner Production Awards for Consultants, Trainers and Companies which comprises worksheets from previous volumes.

