ATME College of Engineering

13th K M Stone, Bannur Road, Mysore – 570028

A T M E

College of Engineering

DEPARTMENT OF CIVIL ENGINEERING

(ACADEMIC YEAR 2024 - 25)

SUBJECT NAME: ENVIRONMENTAL PROTECTION AND MANAGEMENT

SUBJECT CODE: 21CV753

SEMESTER: 7

INSTITUTIONAL MISSION AND VISION

Vision of the Institute

Development of academically excellent, culturally vibrant, socially responsible and globally competent human resources.

Mission of the Institute

- To keep pace with advancements in knowledge and make the students competitive and capable at the global level.
- To create an environment for the students to acquire the right physical, intellectual, emotional and moral foundations and shine as tourch bearers of tomorrow's society.
- To strive to attain ever-higher benchmarks of educational excellence

DEPARTMENT VISION AND MISSION

Vision of the Department

To develop globally competent civil engineers who excel in academics, research and are ethically responsible for the development of the society.

Mission of the Department

- To provide quality education through faculty and state of art infrastructure
- To identify the current problems in society pertaining to Civil Engineering disciplines and to address them effectively and efficiently
- To inculcate the habit of research and entrepreneurship in our graduates to address current infrastructure needs of society

Program outcomes (POs)

Engineering Graduates will be able to:

PO1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes (PSOs)

PSO1: Provide necessary solutions to build infrastructure for all situations through competitive plans, maps and designs with the aid of a thorough Engineering Survey and Quantity Estimation.

PSO 2: Assess the impact of anthropogenic activities leading to environmental imbalance on land, in water & in air and provide necessary viable solutions revamping water resources and transportation for a sustainable development

Program Educational Objectives (PEOs)

PEO 1- Engaged in professional practices, such as construction, environmental, geotechnical, structural, transportation, water resource engineering by using technical, communication and management skills.

PEO 2- Engaged in higher studies and research activities in various civil engineering fields and life time commitment to learn ever changing technologies to satisfy increasing demand of sustainable infrastructural facilities.

PEO 3- Serve in a leadership position in any professional or community organization or local or state engineering board

PEO 4- Registered as professional engineer or developed a strong ability leading to professional licensure being an entrepreneur.

B. E. CIVIL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VII

ENVIRONMENTAL PROTECTION AND MANAGEMENT

Course Code	21CV753	CIE Marks	50
Teaching Hours/Week(L:T:P)	(3:0:0)	SEE Marks	50
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to gain knowledge in Environmental protection and Management systems

Module -1:

Environmental Management Standards: Unique Characteristics of Environmental Problems – Systems approach to Corporate environmental management - Classification of Environmental Impact Reduction Efforts - Business Charter for Sustainable Production and Consumption – Tools, Business strategy drivers and Barriers - Evolution of Environmental Stewardship. Environmental Management Principles - National policies on environment, abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection.

Module -2:

Environmental Management Objectives: Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking. Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies.

Module -3:

Environmental Management System: EMAS, ISO 14000 - EMS as per ISO 14001– benefits and barriers of EMS – Concept of continual improvement and pollution prevention - environmental policy – initial environmental review – environmental aspect and impact analysis – legal and other requirements- objectives and targets – environmental management programs – structure and responsibility – training awareness and competence-communication – documentation and document control – operational control – monitoring and measurement – management review.

Module -4:

Environmental Audit: Environmental management system audits as per ISO 19011- – Roles and qualifications of auditors - Environmental performance indicators and their evaluation – Non conformance – Corrective and preventive actions -compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit.

Module -5:

Applications: Applications of EMS, Waste Audits and Pollution Prevention Control: Textile, Sugar, Pulp & Paper, Electroplating, Tanning industry. Hazardous Wastes - Classification, characteristics Treatment and Disposal Methods, Transboundary movement, disposal.

Course outcomes: After studying this course, students will be able to:

1. Appreciate the elements of Corporate Environmental Management systems complying to international environmental management system standards.
2. Lead pollution prevention assessment team and implement waste minimization options.
3. Develop, Implement, maintain and Audit Environmental Management systems for Organizations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.

- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Reference Books:

1. Christopher Sheldon and Mark Yoxon, "Installing Environmental management Systems – a step by step guide" Earthscan Publications Ltd, London, 1999.
2. ISO 14001/14004: Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2004
3. ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002
4. Paul L Bishop „Pollution Prevention: Fundamentals and Practice, McGraw- Hill International, Boston, 2000.
5. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001.

Module – 1
Environmental Management Standards

Structure

1.0 Introduction

The term environment is coined from the French word 'environia,' which means to surround. The environment includes all the living and non-living components close to us and with whom we have daily interactions which are necessary for our survival.

It is the area in which we operate and includes all elements of nature. Organisms, including human beings, interact with the components of their environment to sustain life.

1.1 Objectives

This course will enable students to gain knowledge in Environmental protection and Management systems

1.2 Unique characteristics of Environmental Problems

1. Genetic Modification of Crops: Environmental issues caused by man-made chemicals are becoming clearer. For example, there has been a 90% reduction in the Monarch butterfly population in the United States that can be linked to weed killers that contain glyphosate.

There is also some speculation that genetically-modified plants may leak chemical compounds into soil through their roots, possibly affecting communities of microorganisms.

2. Waste Production: The average person produces 4.3 pounds of waste per day, with the United States alone accounting for 220 million tons per year. Much of this waste ends up in landfills, which generate enormous amounts of methane.

Not only does this create explosion hazards, but methane also ranks as one of the worst of the greenhouse gases because of its high global warming potential.

3. Population Growth: Many of the issues listed here result from the massive population growth that Earth has experienced in the last century. The planet's population grows by 1.13% per year, which works out to 80 million people.
This results in a number of issues, such as a lack of fresh water, habitat loss for wild animals, overuse of natural resources and even species extinction. The latter is particularly damaging, as the planet is now losing 30,000 species per year.

4. Water Pollution: Fresh water is crucial to life on Earth, yet more sources are being polluted through human activities each year. On a global scale, 2 million tons of sewage, agricultural and industrial waste enters the world's water every day.
Water pollution can have harmful effects outside of contamination of the water we drink. It also disrupts marin

5. Overfishing: It is estimated that 63% of global fish stocks are now considered overfished. This has led to many fishing fleets heading to new waters, which will only serve to deplete fish stocks further.
Overfishing leads to a misbalance of ocean life, severely affecting natural ecosystems in the process. Furthermore, it also has negative effects on coastal communities that rely on fishing to support their economies.
e life, sometimes altering reproductive cycles and increasing mortality rates.

6. Deforestation: The demands of an increasing population have resulted in increasing levels of deforestation. Current estimates state that the planet is losing 80,000 acres of tropical forests per day. This results in loss of habitat for many species, placing many at risk and leading to large-scale extinction. Furthermore, deforestation is estimated to produce 15% of the world's greenhouse gas emissions.

7. Urban Sprawl: The continued expansion of urban areas into traditionally rural regions is not without its problems. Urban sprawl has been linked to environmental issues like air and water pollution increases, in addition to the creation of heat-islands.
Satellite images produced by NASA have also shown how urban sprawl contributes to forest fragmentation, which often leads to larger deforestation

8. Acid Rain: Acid rain comes as a result of air pollution, mostly through chemicals released into the environment when fuel is burned. Its effects are most clearly seen in aquatic ecosystems, where increasing acidity in the water can lead to animal deaths.
It also causes various issues for trees. Though it doesn't kill trees directly, acid rain does weaken them by damaging leaves, poisoning the trees and limiting their available nutrients.

9. Ozone Layer Depletion: Ozone depletion is caused by the release of chemicals, primarily chlorine and bromide, into the atmosphere. A single atom of either has the potential to destroy thousands of ozone molecules before leaving the stratosphere.

Ozone depletion results in more UVB radiation reaching the Earth's surface. UVB has been linked to skin cancer and eye disease, plus it affects plant life and has been linked to a reduction of plankton in marine environments.

10. Ocean Acidification: Ocean acidification is the term used to describe the continued lowering of the pH levels of the Earth's oceans as a result of carbon dioxide emissions. It is estimated that ocean acidity will increase by 150% by 2100 if efforts aren't made to halt it.
This increase in acidification can have dire effect on calcifying species, such as shellfish. This causes issues throughout the food chain and may lead to reductions in aquatic life that would otherwise not be affected by acidification.

11. Air Pollution: Air pollution is becoming an increasingly dangerous problem, particularly in heavily-populated cities. The World Health Organization (WHO) has found that 80% of people living in urban areas are exposed to air quality levels deemed unfit by the organization.
It is also directly linked to other environmental issues, such as acid rain and eutrophication. Animals and humans are also at risk of developing a number of health problems due to air pollution.

12. Lowered Biodiversity: Continued human activities and expansion has led to lowered biodiversity. A lack of biodiversity means that future generations will have to deal with increasing vulnerability of plants to pests and fewer sources of fresh water.
Some studies have found that lowered biodiversity has as pronounced an impact as climate change and pollution on ecosystems, particularly in areas with higher amounts of species extinction.

13. The Nitrogen Cycle: With most of the focus being placed on the carbon cycle, the effects of human use of nitrogen often slips under the radar. It is estimated that agriculture may be responsible for half of the nitrogen fixation on earth, primarily through the use and production of man-made fertilizers.
Excess levels of nitrogen in water can cause issues in marine ecosystems, primarily through overstimulation of plant and algae growth. This can result in blocked intakes and less light getting to deeper waters, damaging the rest of the marine population.

14. Natural Resource Use: Recent studies have shown that humanity uses so many natural resources that we would need almost 1.5 Earths to cover our needs. This is only set to increase as industrialization continues in nations like China and India.
Increased resource use is linked to a number of other environmental issues, such as air pollution and population growth. Over time, the depletion of these resources will lead to an energy crisis, plus the chemicals emitted by many natural resources are strong contributors to climate change.

15. Transportation: An ever-growing population needs transportation, much of which is fueled by the natural resources that emit greenhouse gases, such as petroleum. In 2014, transportation accounted for 26% of all greenhouse gas emissions.
Transportation also contributes to a range of other environmental issues, such as the destruction of natural habitats and increase in air pollution.

16. Polar Ice Caps: The issue of the melting of polar ice caps is a contentious one. While NASA studies have shown that the amount of ice in Antarctica is actually increasing, these rises only amount to a third of what is being lost in the Arctic.
There is strong evidence to suggest that sea levels are rising, with the Arctic ice caps melting being a major contributor. Over time, this could lead to extensive flooding, contamination of drinking water and major changes in ecosystems.

17. Climate Change: The majority of the issues previously listed contribute or are linked to climate change. Statistics created by NASA state that global temperatures have risen by 1.7 degrees Fahrenheit since 1880, which is directly linked to a reduction in Arctic ice of 13.3% per decade.The effects of climate change are widespread, as it will cause issues with deforestation, water supplies, oceans and ecosystems. Each of these have widespread implications of their own, marking climate change as the major environmental issue the planet faces today.

1.3 Systems Approach to corporate environmental Management

A system approach is identifying, understanding, and managing integrated and interdependent processes and their risks that contribute to the organization's environmental management system effectiveness.

Reviewing the inputs and outputs of each process as only a section of the company as a whole contributes to understanding the effects on other processes within the organization. This approach helps managers avoid analyzing problems in isolation.

The most common system model used for environmental management is the ISO 14001. There have been other models, such as the European Eco-Management and Audit Scheme (EMAS) and the Responsible Care model, developed by the American Chemical Council (ACC).

Many organizations, when implementing their environmental management system (EMS) to ISO 14001 requirements, have used the PDCA methodology, based on Deming's “Plan-Do-Check-Act,” implemented in post-WWII Japan.

The focus in the twenty-first century has been on the environmental revolution, and the ISO management system's emphasis has been on continual improvement. In 1995, ISO developed the Three-Step Process: Identify, Insure, Improv for management system implementation. These three steps can be applied not only to quality but also to implementation of an environmental management system

1.4 Environmental impact reduction efforts

Use energy more efficiently: Producing electricity and natural gas and delivering it to your door generates greenhouse gas emissions. Installing energy-efficient building systems and

equipment can save energy and reduce your environmental footprint. See the Commercial or Industrial energy efficiency tools for recommendations that are tailored to your business segment.

Install renewable: Clean, renewable energy systems, such as solar and wind, can reduce your impact on the environment significantly while lowering your energy bill. A variety of federal, state and local incentives are available to make installing renewable energy more affordable. See the Database of State Incentives for Renewables and Efficiency (DSIRE) for information about incentives available in your area

Conserve water: Energy is used (and emissions generated) to heat the water used in your facility and process waste water. Reduce water heater temperatures and repair leaks. Install low-flow showerheads and aerated faucets to reduce the amount of water used; this can be especially effective in lodging and multi-family facilities. Facilities with high hot water demand, such as hospitals and restaurants, should consider heat recovery to capture the energy from waste fluids to heat or preheat water.

Reduce, reuse and recycle: Your environmental footprint goes beyond energy use and your business. All of the materials and equipment in your facility must be produced and shipped there, and then disposed of—all of which impacts the environment. Look for ways to use less; it could be something as simple as printing on both sides of paper or developing a better preventive maintenance program to make equipment last longer. Establish a companywide recycling program.

Travel less: Employees driving to and from work produce a substantial amount of air pollution. Encourage (or subsidize) employees to use public transportation or organize car pools, and allow employees to work from home whenever possible. Minimize business travel through web conferencing, email and other low-emission communications. If you maintain a fleet of vehicles, use them only when needed and look for fuel-efficient models.

Consider near sourcing: All businesses require resources to function, whether it is office supplies or raw materials for manufacturing. Transporting these resources to your door uses energy and creates emissions. Near sourcing—using vendors close to your business—is a growing trend that can reduce your environmental impact and may save you money as well.

Ship goods more efficiently: If your business delivers products, consider ways to reduce your shipping emissions. Ground shipments, by rail or truck, are generally more fuel-efficient than shipping by air. Fewer, full ground shipments will use less fuel than frequent light loads. If you do not have enough goods for full shipments, consider teaming up with other local businesses.

1.5 Business charter for sustainable production and consumption

Sustainable economic growth provides the foundation and resources for societies to develop and prosper, and for people to meet their needs and pursue their aspirations. It helps enable economic empowerment and poverty eradication, advance environmental stewardship; and

contribute to dealing with the trans-boundary global challenges highlighted by the UN Sustainable Development Goals.

At the heart of economic growth are innovative, successful, and responsible businesses operating within strong, forward-looking governance and policy frameworks.

Now more than ever, sustainable development depends on the solutions, capabilities, contributions and engagement of business. ICC believes this entails:

- Innovation in all dimensions of sustainable development so as to develop more integrated strategies, policy and decision-making.
- Leadership and collaboration to leverage the mutually-reinforcing and cross-cutting elements of integrated policy-making.
- Integrated governance structures fostering greater policy coherence between economic, environmental and development objectives.
- Efforts by all actors to reconcile short-term pressures with longer-term strategies to deal with the multiplicity of economic, societal, and environmental challenges and opportunities in an integrated manner.
- Bottom up and top down actions pursued simultaneously by governments and business in support of sustainable growth. A one-size-fits-all approach will not be effective, nor will policies that work in silos.
- Multilateral and cross-cutting approaches across countries and sectors, which are indispensable in the global marketplace.

ICC and sustainable development ICC has played a long-standing role in promoting responsible business conduct and remains committed to providing through leadership to deliver sustainability solutions.

In 1991, only four years after the milestone Brundtland report ―Our Common Future‖, ICC launched its first Business Charter for Sustainable Development, voicing the first world business position on sustainable development. The Charter was subsequently updated in 2000 and 2015, with the latest version reflecting the new approach to sustainable development and its economic, societal, and environmental dimensions.

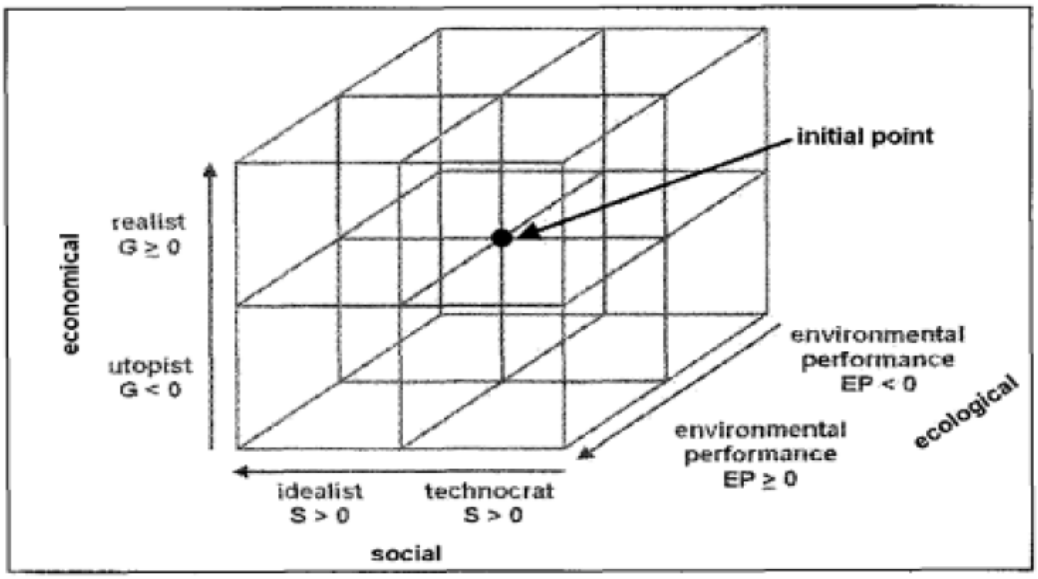
The 2015 Business Charter for Sustainable Development has been specifically designed to help companies contribute to the SDGs' implementation. Based around eight guidelines, it sets out a strategic framework to help companies place sustainability at the heart of their operations; it calls on the widest range of enterprises to enhance their sustainability performance; it also calls for enhanced co-operation to support sustainable growth. Sustainable development as a business priority

- To recognize the business contribution to sustainable development as a key priority and an enabler for long-term business success.
- To build the necessary awareness and understanding amongst its employees, shareholders, customers, and other stakeholders.
- To clarify and integrate sustainability into its strategies, leadership principles, operations, activities and investments according to each business' individually relevant context.
- To govern its business with integrity, develop best practices in any relevant area of work, and promote ethical conduct, including fighting corruption.

1.6 Tools for Sustainable Business Management

Specific tools for translation of general requirements of sustainable development into manageable demands are necessary. The sustainability balanced scorecard is the central tool for the development and implementation of sustainable business strategies. In order to identify the position of an enterprise related to sustainable development the concept of sustainability cube is discussed. With this instrument the social, economical and ecological dimension of sustainable development within an enterprise can be measured. A tool for sustainable design of new products or services is the sustainable orientated quality function deployment. This concept combines the needs of the market and customers with the principles of sustainable development.

Sustainable cube: In order to determine organisation's position in the light of sustainable development the "sustainable cube" can be applied 191. This tool contains the three perspectives of sustainable development - the economical, the ecological and the social one - and proposes a metric system for each of them. The position within the cube allows one to define strategies for further sustainable management. The cube can be used for the whole organisation, for parts of an organisation or for individual products or services. The economic perspective can be measured with common economic concepts like economic value added, option pricing theory, shareholder value, contribution accounting, target costing or product profitfloss accounting. Economic value added, shareholder value, options price theory and contribution accounting can be used to analyse the whole organisation. Target costing is a tool for product-specific questions. Meanwhile specific variations of shareholder value or contribution accounting were developed including ecological requirements (spec. ecological shareholder value [lO], environmental contribution accounting [ll]). The ecological perspective can be measured by life cycle assessment resp. Environmental performance measurement and indicators. The chosen method should refer to principles of sustainable development, the methods suitably are assessing not-monetary and quantitative. The methods Sustainable Process Index (SPI) [12], Material Input per Service (MIPS) [13], Eco indicator 99 [l41 and Eco-Points [l 51 are in discussion



These methods allow the measurement of ecological effects of products, processes or organisations. Application is usually complex, and the methods are debatably. If environmental effects can be evaluated by experts, also indicators combined with ABC-analysis can be used [16]. Social perspective can be measured by indicators. Questions of legal compliance of social standards and laws, of human rights and of gender mainstrearning, to give a few examples, are here in focus. For practical use, the relevant indicators for each perspective have to be defined for a specific organisation. The next step is measuring and collecting the needed data, due to evaluate and calculate each indicator. The sustainable cube is an instrument used in organisational decision making processes - therefore evaluation is of a relative characteristic. The organisation starts in the centre of the cube and can derivate strategies for each sustainability perspective to improve the position. The cube can be used for benchmarking purposes, too, but in this case all partners of the benchmarking process have to use the same criteria, indicators and methods. The lettering of the axis is characterized by "W, "S" and "EP and is measured through specific criteria valid for the organisation. The ideal position of measurement point within the cube would be the top of each perspective, economic realistic, social ideal, with high environmental performance. An unalterable demand for the position of each organisation is section with $G > 0$, otherwise they lose money. In this case the organisation has no economic perspective, and there is no continuous success in the ecological and social perspective.

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Table 2: Classical model for QFD [23].

Step	Matrix	What	How
1	House of Quality	Voice of the Customer	Technical Performance Measures
2	Subsystem Design Matrix	Technical Performance Measures	Piece-Part Characteristics
3	Piece Part Design Matrix	Piece-Part Characteristics	Process Parameters
4	Process Design Matrix	Process Parameters	Production Parameters

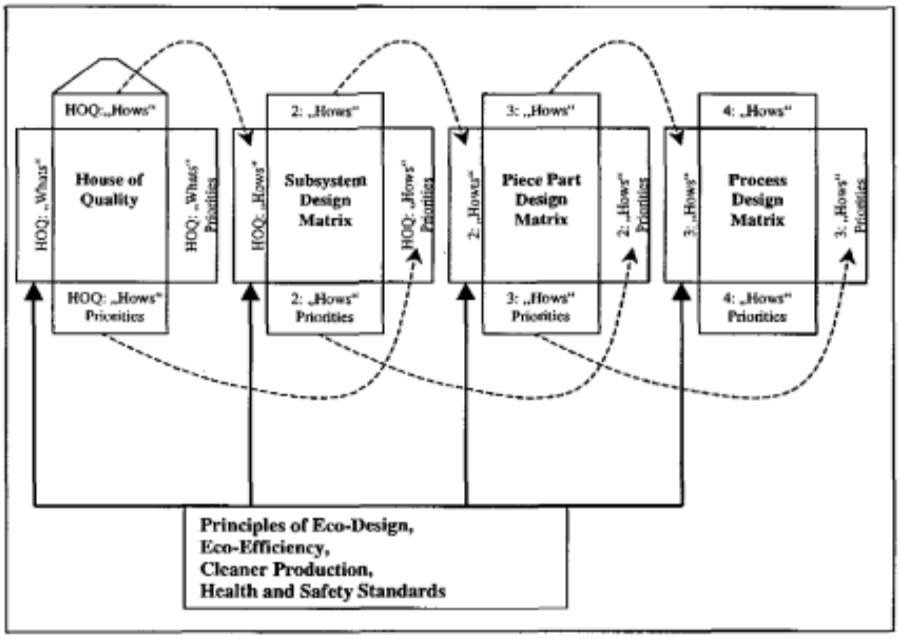


Figure 2: QFD – interrelated matrices and impact of sustainability criteria.

Sustainability requirements can be included on all steps of the Qm> process. For the House of Quality (HOQ), the subsystem design matrix and the piece part design matrix the relevant criteria can be derived from the principles of eco design as well as from criteria's concerning social resp. health and safety issues. Eco-Efficiency Criteria and principles of Cleaner Production can be integrated into the process design matrix, but it has to be noted, that these principles will also have an impact to matrix 1 - 3 (see Table 2). Eco-Efficiency means creating more value with less impact [24]. The goal of the concept of Cleaner Production are environmental sound processes, in order to avoid harmful emissions and waste which have to be cleaned up with so called end-of-pipe technologies. The objective of Eco-Design is to maximize the benefit and to minimize the environmental impact of a product or service. Additionally requirements of corporate strategy are important. Therefore tool employment has to be seen in the light of the general objectives which are management for example with a SBSC within a Generic Management System

1.7 Environmental Stewardship

- Human responsible consumption, protection of the natural environment or corrective activities that could be achieved through conservation efforts and sustainable practices.
- The responsible use and management of natural resources in a way that takes a full and balanced account of the interests of society, future generations, and other species while accepting significant answerability to society for these actions.
- Reduce the number of bags you use for shopping. Use reusable bags.
- Reduce water usage and waste by closing taps and lower the flow to the smallest needed to do the job in reasonable time.
- Reduce the amount of fuel you use by choosing smaller, lighter vehicles. Carpool. Live close to where you work. Use public transit if you can.

Environmental stewardship ties in with land stewardship and good agricultural practices which farmers would not truly practice if they care about obtaining optimal yields for an infinite period of time.

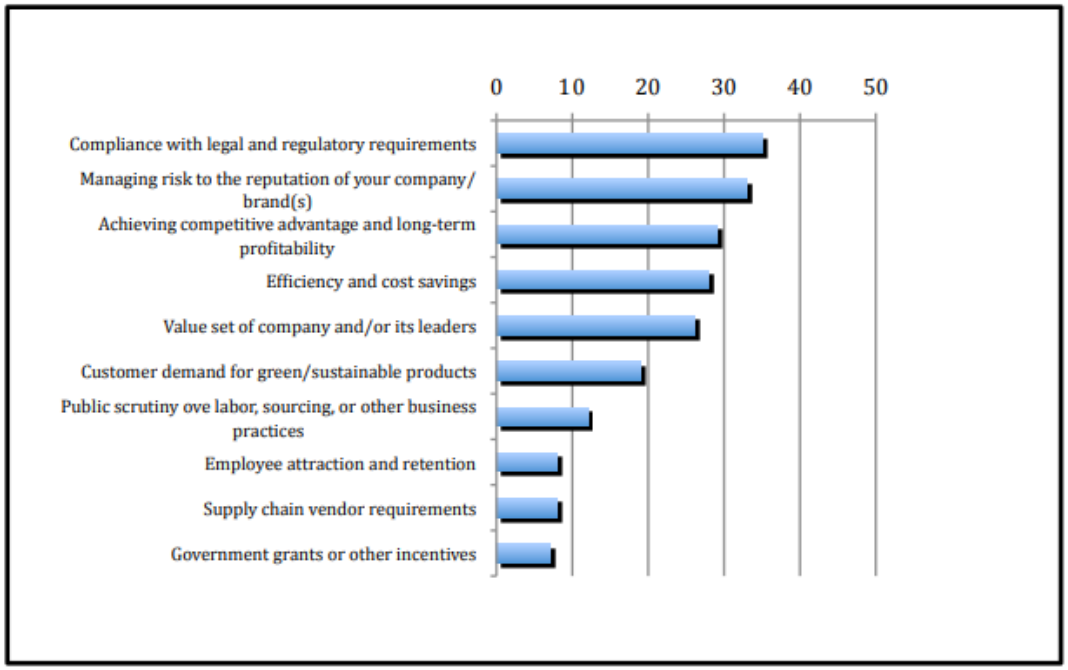
It includes things like:

- Planting trees around fields to act as wind break barriers which reduce soil erosion due to winds blowing across cultivated ground.
- Reduced tillage or no tillage methods of growing crops. This also helps reduce soil erosion by wind because less or nose bare soil is left open to the elements.
- Incorporation of plant waste, such as stems, back into the soil to add organic matter. This means healthier soil and corresponding increased yields. It also can mean soil which is more open allowing for better drainage.
- Not using equipment on soil when it is too wet resulting in compaction. This can mean reduced yields and reduced drainage. Also using suitable equipment to match the soil such as tracked equipment versus just plain wheels on muck type soil.
- Applying the correct amount of fertilizer or manure at the correct time to achieve optimal growing results without having run off issues. Allowing fertilizer or manure to leach into waterways is harmful to the environment as well as a waste of the resource. As part of this, incorporating the fertilizer or manure into the soil

1.8 Drivers of sustainability

The business case for sustainability has been at the forefront of much of the literature. Some of the most commonly mentioned drivers/benefits of sustainability include: competitive advantage, reduced costs, increased sales, improved image and reputation, and increased employee motivation (FSC, 2010; Jenkins, 2006; KPMG, 2008; Makower, 2010; Masurel, 2007; Morsing, 2006; Simpson, Taylor, & Barker, 2004; Werbach, 2009; Willard, 2005). In December 2010, the American Institute of Public Accountants (AICPA), Canadian Institute of Chartered Accountants (CICA) and the Chartered Institute of Management Accountants (CIMA) released a report on drivers to sustainability. This report looked at the evolution of CR practices in Canada, the US and the UK;

The top three drivers to sustainability for large organizations were:
(1) Compliance with legal and regulatory requirements,
(2) Managing risk to the reputation of your brand and
(3) Achieving competitive advantage and long-term profitability (see figure 6) (AICPA, CIMA, CICA, 2010, p.5).
The survey respondents were small (under 1000 employees) and large (over 1000 employees) organizational leaders who are members of these three associations. Based on the literature, the most important drivers for sustainability are external to 18 the company and focus on competitive advantage, compliance with regulatory bodies and managing risk and reputation. Jenkins (2006) concluded that external drivers are: improved image and reputation, better market position; and internal drivers are: increased employee motivation, cost savings and increased efficiency. Figure 6 – Sustainability drivers for large companies



Large organizations are also more inclined to have formal sustainability departments as well as formal reporting standards, and 79% of companies currently had a sustainability strategy

1.9 Barriers

Sustainable development has been widely promoted as a holistic concept which aims or targets to integrate social, economic and cultural policies to ensure high-quality growth. However, there are barriers combating the implementation of sustainable development. These barriers are, according to an UK essay and other materials, the following:

Economic and financial barriers: Economists observed that the dominating development model tends to focus on economic growth as precedence rather than people's rights or welfare, and environmental processes and limits. This requires a shift in the worldview from treating the environment as part of the economy to treating the economy as part of the

environment; strategically this means the economy should be adapted to ensure environmental services are maintained.

Innovation Barriers: In the educational sector there is a lack of innovation-oriented research. This means that there has to be a closer connection between research institutes and the economy, which would also overcome problems concerning the knowledge transfer to applications in real life.

Social barriers: Population growth, paired with unsustainable consumption and production patterns among the wealthy, are the biggest social challenges to achieving sustainable development in the world. Absent of a significant change in human behavior, sustainability will not be potential. There are other social barriers which are: The marginalization of the poor and entrenched inequities Limited awareness about sustainable development. Environmental issues among both politicians and the wider public fragmented civil society. Inadequate interaction between civil society and government. Insufficient incentives to for the private sector to pursue sustainable development.

Political barriers: Inadequate economic, social and environmental methods for policies, plans and projects are the major barrier combating the implementation of sustainable development.

Poor monitoring and evaluation systems: A basic problem is lack of specific targets (globally, nationally and at local level), measurement and data to track progress, resulting in a lack of information available to decision-makers. It is suggested for strengthening monitoring and evaluation of sustainable development strategies in order to establish a dynamic improvement process, with an objective of increasing their effectiveness. It is recommended that governments should turn up deeper and assess the socio-economic impacts of developmental projects, rather than the outcome alone.

Institutional barriers: Institutional barriers as a result of lack of institutional experience to operate all the mechanism of democratic system has been combating and frustrating sustainable development in many developing countries.

1.10 Environmental Management Principles

Principles of environmental management are a set of rules and guidelines that help attain desirable environmental outcome. Principles of environmental management, refers to procedure, government, industries and people should follow. Environmental management principles have been drivers, in response to economic and social problems which may arise as a result of any economic undertaking. This includes agriculture, mining, industries and natural disasters likely to damage the environment.

7 Key Principles Of Environmental Management

1. Polluter Pays Principle (PPP)
2. User Pays Principle (UPP)
3. Precautionary Principle (PP)

4. Principle of Responsibility
5. Principle Of Effectiveness and Efficiency
6. Principle of Proportionality
7. Principle Of Participation

7 Key Principles Of Environmental Management

Below are the main principles of environmental management important for environmental decision making and any undertaking, likely to damage the environment. 7 main principles of environmental management, which play major role in economic, social and environmental decision making, including policy formulation.

1. Polluter Pays Principle (PPP): Most economists around the world suggested for many years that the only to ensure clean safe environment was through this principles of environmental management. Experts suggested that firms producing hazard chemicals and pollutants affecting the environment must pay

After many countries embarked on measuring damage, through environmental impact assessment (EIA). It was noted that pollution must be linked to damage and pollution caused, therefore prices must be according to damages caused the industry.

Polluter pays principle, ensures absolute liability for any damage and harm caused by the industry and firms. It makes the process and procedure for compensation easy in an event where there victims affected. Another important aspect of this among principles of environmental management is that the cost gets shared and its easy to repair or reduce damages.

2. User Pays Principle (UPP): This principle has been derived from the polluter pays principle which gives the responsibility to users for them to pay for any long run cost and marginal environmental damage or pollution.

It includes users bearing the costs for utilizing resources, services and treatment services whenever the resources are consumed and been used.

For instance consumption of water which comes from rivers, each household is required to pay certain fee towards the service. Farmers are required to pay land fees, which part of the money goes towards cleaning and budgetary funding for developing EIA systems to help predict, protect and prescribe measure s to protect the environment from economic activities

3. Precautionary Principle (PP): This proposes protecting the environment through precautionary measures, especially for heavy activities that might cause more damage to the environment. Precautionary principle has major objectives which include measuring primary and secondary activities posing a threat to the environment.

4. Principle of Responsibility: Among principles of environmental management, this states each person and firm needs to be held accountable and take responsibility to maintain safe, clean and sustainable development. Ecological sustainability should be attained by ensuring the use of resources is properly managed and not wasted, people must go about knowing that

one of their duties is to protect the environment, safe applies for firms and corporations extracting and committing gasses polluting the environment.

5. Principle Of Effectiveness and Efficiency: It the responsibility of government in every country, city or state to ensure, well structured policies and procedures are put in place for essential waste management. Failure to properly mage waste can lead to diseases, soil problems, chemical build ups, water born diseases. Hence its essential that through the principle of effectiveness and efficiency, major agencies and council do everything possible to reduce waste building up and control dump sites for garbage.

6. Principle of Proportionality: This refers to striking a balance between development and protecting the environment. Building of basic essential infrastructure through development has been considered major part for Human development, therefore, protecting the environment but so does development. Without the environment which provides for land, man would not have where to build homes.

7. Principle Of Participation: Every citizen, person, government and firms have a responsibility to participate in environmental decision making and protection policies. Through collective collaboration in the affairs of the environment its easy to foster a shift and wave reflecting need to protect the environment.

Every individual should take a major step and contribute to issues relating to solid waste management, garbage collection, construction, chemicals, gaseous omission and demolition materials which are likely to affect the environment and how to reduce the impact.

1.11 National Environment Policy (NEP)

The National Environment Policy (NEP) by the Ministry of Environment and Forests (MoEF) aims at mainstreaming environmental concerns into all developmental activities. It emphasises conservation of resources, and points that the best way to aid conservation is to ensure that people dependent on resources obtain better livelihoods from conservation, than from degradation of the resources. It argues that environmental degradation often leads to poverty and poor health outcomes among populations.

The document goes on to highlight the principles underlying the policy that emphasise the

- Important role of human beings in the sustainable development processes
- The non negotiability and incomparable value of environmental resources
- Right to development for all
- Equity in the use of environmental resources and

The need for the decentralised and multispectral approach in dealing with environmental issues.

The objectives of the policy include:

- Conservation of critical environmental resources
- Intra-generational equity
- Livelihood security for the poor

- Inter-generational equity
- Integration of environmental concerns in economic and social development
- Efficiency in environmental resource use
- Environmental governance
- Enhancement of resources for environmental conservation

1.12 Charter on Corporate Responsibility for Environmental Protection (CREP)

Ministry of Environment & Forest (MoEF) launched the Charter on "Corporate Responsibility for Environmental Protection (CREP)" in March 2003 with the purpose to go beyond the compliance of regulatory norms for prevention & control of pollution through various measures including waste minimization, in-plant process control & adoption of clean technologies. The Charter set targets concerning conservation of water, energy, recovery of chemicals, reduction in pollution, elimination of toxic pollutants, process & management of residues that are required to be disposed off in an environmentally sound manner. The Charter enlists the action points for pollution control for various categories of highly polluting industries. The Task Forces were constituted for monitoring the progress of implementation of CREP recommendations/ action points.

Action Points under CREP for Tannery Sector

1. Chrome Recovery

i) All the chrome-tanning units in the country will have the Chrome Recovery Plant either on individual basis or on collective basis in the form of Common Chrome Recovery Plant and use the recovered chrome in the tanning process. By December 2004

ii) Common Chrome Recovery Plant is to be installed and commissioned at Kanpur, for which the Feasibility Report has already been prepared. All the chrome tanning units will make their financial contribution to the extent of 10% By June 2003

ii) Recovered Chromium is to be utilized in tanning process By December 2005

2. Waste Minimization Measures

i) Waste minimization circles will be formed in all the clusters of tanneries in the country to implement waste minimization measures and for adoption of clean technologies March 2004

ii) Waste minimization measures as identified by the Task Force to be implemented in all the tanneries By December 2005

3. Reduction of Water Consumption in Tannery Units

i) All the tanneries will install water meters and flow meters to measure actual consumption and waste water discharge. By December 2003

ii) Water consumption rates will be brought down to 28 m 3 /tonne of hides by taking water conservation measures. By December 2003

4. Compliance of standards All CETPs and ETPs will take the following measures:

i) Deployment of qualified and well trained staff for O & M of the ETPs/CETPs. By December 2003

ii) Installation of automatic monitoring instruments by CETPs/large tanneries. By December 2003
iii) Separate Energy meters for ETPs/CETPs By December 2003
iv) Replacement of open anaerobic lagoons with cleaner technology options will be implemented By December 2005
v) Implementation of guidelines developed by CPCB for Health & Safety of worker employed in the industry / ETP/ CETP.
vi) All large tannery units (processing more than 5 tonne/day of hides/skins) will undertake Environmental Auditing on annual basis. By June 2004
vii) Modification/up-gradation of the CETPs/ETPs wherever necessary will be taken up by tannery units and CETP management By December 2005

5. Management of Total Dissolved Solids (TDS) For TDS management the following methods will be adopted:
i) Manual/mechanical desalting By December 2003
ii) Use of cleaner technology for less use of salt By December 2005
iii) High Rate Transpiration System for effluent treatment will be adopted wherever feasible By December 2004
iv) Treated wastewater will be mixed with the sewage wherever feasible and further treated and the treated combined effluent will be used on land for irrigation. By December 2005

6. Solid Waste Management For solid waste management the following methods will be adopted:
: i) Utilization of process sludge for by-product recovery. By December 2004
ii) Resource recovery from process sludge and ETP sludge in the form of Biogas By December 2004
iii) Safe disposal of hazardous sludge and non-hazardous solid wastes By December 2005

7. Salts from Solar Evaporation The following methods will be adopted depending on the site specific conditions:
i) Reuse of recovered salt. By December 2005
ii) Safe land disposal or Sea disposal

8. Use of Boron bearing compounds will be dispensed with. By December 2003

9. Ground water quality monitoring to be strengthened wherever the treated effluents are applied on land for irrigation. By December 2004

10. Implementation of recommendations of the Task Force constituted by the MOEF, Govt.of India will be commenced by June 2003. By June 2003

1.6 Recommended questions

1. Enumerate the various environmental management principles and explain any two.
2. Enumerate the various drivers and barriers for sustainable development

3. Enumerate the business charter tools for sustainable production and consumption

1.7 Outcomes

Appreciate the elements of Corporate Environmental Management systems complying to international environmental management system standards.

1.8 Further Reading

1. https://web.ccsu.edu/faculty/kyem/GEOG433/International_Problems/INTERNATIONAL_ENVIRONMENTAL_PROBLEMS.htm
2. https://www.yourarticlelibrary.com/environment/environmental-impact-assessment-definition-roles-and-classification/27468

Module – 2
Environmental Management Objectives

Structure

2.0 Introduction

Environmental management is an organized approach to supervising the environmental affairs of an organization. The main aim of this management process is to minimize waste. An effective environmental management process reduces carbon emissions, prevents pollution, and helps in processing all the waste and wise usage of energy and resources. Environmental management has been emerged and also accepted as a tool for sustainable development. Environmental management is important for environmental planning, this will help us to make use of the earth's resources in a sustainable way and help preserve the quality of the environment.

2.1 Objectives

This course will enable students to gain knowledge in Environmental protection and Management systems

2.2 The Environmental Quality Objectives

1. Reduced Climate Impact In accordance with the UN Framework Convention on Climate Change, concentrations of greenhouse gases in the atmosphere must be stabilised at a level that will prevent dangerous anthropogenic interference with the climate system. This goal must be achieved in such a way and at such a pace that biological diversity is preserved, food production is assured and other goals of sustainable development are not jeopardised. Sweden, together with other countries, must assume responsibility for achieving this global objective.

2. Clean Air The air must be clean enough not to represent a risk to human health or to animals, plants or cultural assets.

3 Natural Acidification Only The acidifying effects of deposition and land use must not exceed the limits that can be tolerated by soil and water. In addition, deposition of acidifying substances must not increase the rate of corrosion of technical materials located in the ground, or water main systems, archaeological objects and rock carvings.

4. A Non Toxic Environment The occurrence of man-made or extracted compounds in the environment must not represent a threat to human health or biological diversity.
Concentrations of non-naturally occurring substances will be close to zero and their impacts on human health and on ecosystems will be negligible. Concentrations of naturally occurring substances will be close to background levels.
5. A Protective Ozone Layer The ozone layer must be replenished so as to provide long-term protection against harmful UV radiation.
6. A Safe Radiation Environment Human health and biological diversity must be protected against the harmful effects of radiation.
7. Zero Eutrophication Nutrient levels in soil and water must not be such that they adversely affect human health, the conditions for biological diversity or the possibility of varied use of land and water.
8. Flourishing Lakes And Streams Lakes and watercourses must be ecologically sustainable and their variety of habitats must be preserved. Natural productive capacity biological diversity, cultural heritage assets and the ecological and water-conserving function of the landscape must be preserved, at the same time as recreational assets are safeguarded.
9. Good Quality Groundwater Ground water must provide a safe and sustainable supply of drinking water and contribute to viable habitats for flora and fauna in lakes and watercourses.
10. A Balanced Marine Environment, Flourishing Coastal Areas And Archipelagos The North Sea and the Baltic Sea must have a sustainable productive capacity, and biological diversity must be preserved. Coasts and archipelagos must be characterized by a high degree of biological diversity and a wealth of recreational, natural and cultural assets. Industry, recreation and other utilization of the seas, coasts and archipelagos must be compatible with the promotion of sustainable development. Particularly valuable areas must be protected against encroachment and other disturbance.
11. Thriving Wetlands The ecological and water conserving function of wetlands in the landscape must be maintained and available wetlands preserved for the future.
12. Sustainable Forests The value of forests and forest land for biological production must be protected, at the same time as biological diversity and cultural heritage and recreational assets are safeguarded.
13. A Varied Agricultural Landscape The value of the farmed landscape and agricultural land for biological production and food production must be protected, at the same time as biological diversity and cultural heritage assets are preserved and strengthened.
14. A Magnificent Mountain Landscape The pristine character of the mountain environment must be largely preserved, in terms of biological diversity, recreational value, and natural and cultural assets. Activities in mountain areas must respect these values and assets, with a view to promoting sustainable development. Particularly valuable areas must be protected from encroachment and other disturbance.

2.3 The rationale of environmental standards

The purpose of environmental quality standards is to protect quality of life and health by controlling the quantity and quality (mainly in terms of toxicity) of anthropogenic pollutants, emanating mainly from industrial activities, released to the environment.
It includes

2.3.1 Mass and concentration:

- Mass concentration (mass per unit volume e.g. ppb or μg L−1) is the traditional metric to report the environmental concentration (exposure) and toxicity thresholds (dose) of conventional contaminants.
- Mass concentration is also the metric used when investigating the release and fate and transport of conventional contaminants in the environment. It is likely the best suitable metric to represent sedimentation of manufactured NMs after aggregation.
- In addition, there are well-validated methods for NM mass concentration determination, making the production of accurate data easier. Therefore, mass concentration is the current practical choice for a rapid overall assessment of environmental processes related to the larger NM fractions (e.g. sedimentation).
- For example, the mass concentration of fullerene C60 was considered critical to predict the fate of aqueous nanoscale fullerene (C60) suspensions
- Although mass concentration metrics have been widely adopted in the hazard and risk characterization of NMs, they are known to have limitations.
- Few studies have investigated the impact of dose metric (mass, number and surface area) on the dose–response relationship for NMs, but there is no consensus on the best dose metric to express NM toxicity.
- It is likely that the dose metric will be NM-dependent.This is particularly true for polydisperse NM samples where mass concentration primarily reflects larger NM fractions.
- A potential challenge is to quantify mass concentration of specific NMs in complex biological matrices. The NMs can be altered via dynamic interaction with surrounding media. Finally, manufactured NMs are typically present at low concentrations (parts-per trillion to ppb).
- Highly sensitive and specific analytical techniques are required to measure these toxicologically relevant mass concentrations.

2.3.2 Effluent Standards:

➢ They are generally established for the effluent from industry and municipality waste water treatment plant to be discharge into stream, land, sewer, ocean etc.

➢ Effluent standard system is carried out to control the following stream standard system.

➢ No detail stream analysis is required to determine exact amount of waste treatment, effluent standard can serve as a guide to establish the stream classification or during organization of any pollution abutment program.

➢ Unless the effluent standards are upgraded, this system does not provide any effective protection for an over loaded stream.

➢ Main disadvantage of this type of standards is that there is no control over total volume of polluting substances added to stream each day

2.3.3 Stream Standards:

➢ The system is based on establishing classification or standard quality for a stream & regulating any discharge to the extent, necessary to maintain the established stream classification or quality

➢ The primary objective of stream standards is to protect and preserve each stream for its best usage on a equitable basis for both upstream & downstream uses.

➢ The stream standard system is the prevention of excessive pollution regardless of type of industry or other factors such as location of industry or municipality.

➢ Pollution abutment should be considered in the decisions concerning location of a plant just as carefully as the labours, transportation, market & other conditions.

➢ It also allows the public to establish goals for maintaining quality of water for present as well for future needs.

2.3.4 Emission standards:

➢ Emission standards are requirements that set specific limits to the amount of pollutants that can be released into the environment.

➢ Many emissions standards focus on regulating pollutants released by automobiles (motor cars) and other powered vehicles but they can also regulate emissions from industry, power plants, small equipment such as lawn mowers and diesel generators.

An emission performance standard is a limit that sets thresholds above which a different type of emission control technology might be needed.

Emission Norms:-

➢ It was in 1991 that first time emission norms were introduced in India for petrol cars, diesel cars followed in 1992.

➢ Emission norms means some rules (which has specified quantity) decided by the govt for control of air pollution.

➢ Implementation of mandatory catalytic converters in 1995 for the 4 Metro cities, thus reducing pollution further.

2.3.5 Ambient Air Quality Standards (AAQS):

Ambient Air Quality Standards are setup for protecting public health from adverse effects of air pollution and eliminating or reducing to a minimum, those contaminants that are known to be or likely to be hazardous to human health.

Several approaches have been considered for setting air quality standards. Some of these are:

i. Using another community's air as the standard,
ii. Using as standard the quality of air that existed at an earlier time for which it was believed that adverse effects were either nonexistent or tolerable by the community,
iii. Using as standard the quality of air that exists in the community on certain days of good ventilation and
iv. Considering health protection - control cost relationship.

National Ambient Air Quality Standards A National Ambient Air Quality Standard (NAAQS) is a uniform, national standard establishing the maximum permissible

concentration of an air pollutant in the ambient air - the "portion of the atmosphere, external to buildings, to which the general public has access..

“The USEPA has setup two types of standards, viz. "Primary Standards" to protect health with a margin of safety and for "Secondary Standards" to protect welfare

Primary Standards Primary NAAQS define the acceptable concentration of an air pollutant in the ambient air - necessarily to protect health with adequate margin of safety.

Secondary Standards Secondary NAAQS define the concentration of an air pollutant in the ambient air necessary to protect the "public welfare.

“Effects on welfare includes, but is not limited to, effects on soils, water, crops, vegetation, manmade materials, animals, wildlife, weather, visibility and climate, damage to and deterioration of property, and hazards to transportation, as well as effects on economic values and on personal comfort and well- being, whether caused by transformation, conversion, or combination with other air pollutants national environmental standards

2.4 Minimum National Environmental Standards for industrial wastewater (NESs)

National Environmental Standards provide the opportunity for central government to promote the adoption of consistent standards at the regional and district levels.

National environmental standards are regulations which prescribe technical standards, methods or requirement for land use and subdivision, use of the coastal marine area and beds of lakes and rivers, water take and use, discharges, or noise. They can also prescribe technical standards, methods or requirements for monitoring.

Wastewater discharge standards are set (at least) at a national level for centralized treatment systems for salient receiving environments

The key feature of a water body from a discharge perspective is its assimilative capacity i.e., maximum amount of pollution that can be diluted or degraded without affecting preliminary defined designated best uses.

Effluent discharge standards can be concentration-based or load-based. Concentration-based standards are the most common and specify a permissible mass of pollutant per litre.

A limitation of concentration-based standards can be that it does not promote wastewater treatment, since dilution can be used to meet the discharge standard.

The original standards developed in Britain were concentration-based—although those standards assumed a minimum 8-fold dilution in the receiving water body. Most countries in the Global South have adopted discharge standards from the Global North and they have not been developed for their local context

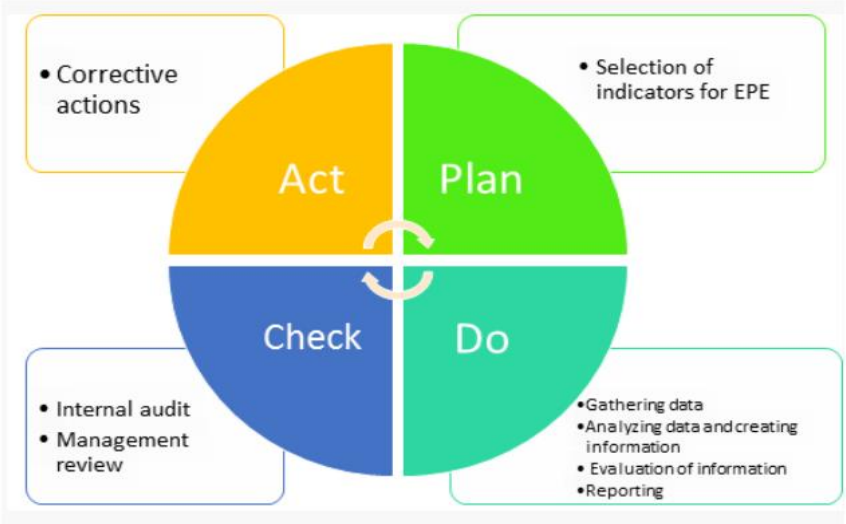
A national environmental standard may set a minimum standard, allowing councils to impose stricter standards in their own plans, it may set a 'starting point' standard, allowing councils to impose more lenient standards, or it may be absolute, so that local rules cannot be more lenient or stricter than the standard.

National environmental standards may contain qualitative or quantitative standards, discharge standards, methods for classifying a resource, methods, processes or technologies to implement standards, non-technical methods and standards and exemptions from standards.

A national environmental standard may:

- Prohibit an activity
- Require resource consent for an activity
- State that a resource consent is not required for an activity
- Allow a resource consent to be granted for an activity only if it complies with conditions specified in the standard and/or in the rules of a regional or district plan
- Restrict the making of a rule or granting of a resource consent
- Require a person to obtain a certificate from a specified person stating the activity complies with a specific term of condition in the national environmental standard
- Specify the relationship between existing rules and the rules in the national environmental standard
- Require the review of a water, coastal or discharge permit
- Determine whether an activity is controlled, restricted discretionary, discretionary or non-complying
- State the matters over which discretion is restricted or control is reserved
- Specify that a resource consent application must be publicly notified or must not be publicly notified or notified on a limited basis.

2.5 Environmental performance evaluation



The environmental performance evaluation (EPE) is an internal process and mechanism that should enable continual management of reliable and verifiable information in order to determine whether the environmental management system meets criteria defined by the management of the organization. The EPE uses indicators for gathering the information, and compares current and previous performance with criteria for environmental performance established by the organization itself.

2.5.1 Environmental performance indicators (EPI)

The standard identifies two categories of EPI — operational performance indicators (OPIs) and management performance indicators (MPIs). A third category — environmental condition indicators (ECI) — measures how an organisation's activities, products and services interact with the natural environment at a local, regional, national or global level.

ISO 14031 provides guidance on the selection of indicators, the measurement and monitoring processes and the subsequent use of the validated data.

Typical EPIs in the first two categories may include:

MPIs relate the management system and address:

- Policy issues and development, eg effectiveness of environmental commitments
- Resource allocation and purchasing
- Human resource issues, eg staff training
- Planning and practices, eg which objectives are being pursued and achieved
- Conformance with regulations and audit programmes.

OPIs relate to performance of operations, including:

- Inputs, eg energy, materials, utilities and contractor services
- Through-puts, eg design, installation, operation and maintenance of buildings, materials used, process equipment and other facilities
- Outputs, eg process emissions, trade effluent, emissions to air, solid and liquid wastes, noise, vibration, light, dust, litter, odour and radiation.

Examples of performance indicator data might include:

- Raw materials consumed (including hazardous substances and materials)
- Quantities of emissions and discharges that can have a significant impact
- Environmental protection measures
- Number of polluting incidents or breaches of compliances which attracted fines, damages or increased costs of regulatory inspections
- Performance indicators such as waste generated per unit of production or energy consumption. indicators

Environmental condition indicators (ECI)

ECIs are principally about the state of the natural environment that may be affected by an organisation's activities, products and services. This will include local air and water quality and the condition of land or whether the soil is contaminated. Overall responsibility for the state of the environmental rests with those governmental and regulatory agencies responsible for protecting and improving it, hence the need for regulatory controls and statutory monitoring regimes.

ECIs refer to those activities and operations that might interact or have an impact on the quality of the natural environment. A key factor is ensuring that emissions to air, discharges to water and waste, meet regulatory compliance, but an organisation may also carry out operations or activities that interact in other ways and should be included in performance evaluation.

ECIs might include:

- Air quality, eg polluting or non-polluting odours that can cause nuisance to local residential areas

- Water condition, eg activities that release water causing turbidity in local streams. Equally, are local water resources suitable for operational use? Is there enough water resource for future business needs?
- Land, eg are activities likely to degrade soil condition? Equally, are there opportunities for enhancing local biodiversity by planting trees, for example?

By monitoring and measuring EPEs in all three categories described above, organisations can identify those activities over which it has control or influence and set improvement priorities accordingly.

2.5.2 Environmental benchmarking

Environmental benchmarking is a business tool that helps companies evaluate their environmental performance and identify operating practices that contribute to superior performance.

Many companies have begun conducting benchmarking studies for the purpose of identifying work processes and practices that influence the environmental performance of their organizations.

Organizations are aware that their operations may have detrimental, mitigating, or even positive impacts on the environment depending upon how the practices are implemented.

The impacts of processes can be quantified and thus used as a statistic to evaluate the organizations

Performance and competitive standing in the industry. For example, there is an increased awareness and interest in the contributions organizations make to climate change and the risks of a variable climate.

The Financial Times FTSE4Good Index, the Dow Jones Sustainability Index, and the Carbon Disclosure Project demonstrate the increased emphasis of investors on organizations' practices related to carbon and its association with climate change.

Although a benchmarking study should be customized with respect to the organization's needs,

The general approach to an environmental benchmarking study is as follows:

- Define criteria for establishing practices as best-in-class;
- Define performance metrics/criteria that address the areas of specific interest and allow for comparison across firms;
- Research industry practices and trends, including collecting and analyzing quantitative and qualitative data on the policies, actions, successes, and failures of industry peers;
- Select individual organizations for study based upon specific criteria that position the organization as leaders in the industry (e.g., environmental indices, sustainability report measures, industry awards);
- Evaluate the overall performance of individual organizations included in the analysis relative to the metrics and develop rankings to identify best-in-class;
- Perform a gap analysis to highlight an organization's strengths and weaknesses relative to the field; and

- Provide targeted recommendations for cutting-edge projects, policies, and initiatives that allow an organization to maximize operational efficiencies, improve environmental quality

2.6 Pollution prevention and pollution control

The Central Pollution Control Board (CPCB) of India is a statutory organization under the Ministry of Environment, Forest and Climate Change (Mo.E.F.C.C.).

It was established in 1974 under the Water (Prevention and Control of pollution) Act, 1974. The CPCB is also entrusted with the powers and functions under the Air (Prevention and Control of Pollution) Act, 1981.

It serves as a field formation and also provides technical services to the Ministry of Environment and Forests under the provisions of the Environment (Protection) Act, 1986.

It Co-ordinates the activities of the State Pollution Control Boards by providing technical assistance and guidance and also resolves disputes among them. It is the apex organization in country in the field of pollution control,as a technical wing of MoEFCC.

The board is led by its Chairperson appointed by the Appointments Committee of the Cabinet of the Government of India The current acting chairman is Shri Tanmay Kumar (August 2021) and the Member Secretary is Dr. Prashant Gargava and reduce operating costs.polution .

CPCB has its head office in New Delhi, with seven zonal offices and 5 laboratories. The board conducts environmental assessments and research. It is responsible for maintaining national standards under a variety of environmental laws, in consultation with zonal offices, tribal, and local governments.

It has responsibilities to conduct monitoring of water and air quality, and maintains monitoring data. The agency also works with industries and all levels of government in a wide variety of voluntary pollution prevention programs and energy conservation efforts.

It advises the central government to prevent and control water and air pollution. It also advises the Governments of Union Territories on industrial and other sources of water and air pollution. CPCB along with its counterparts the State Pollution Control Boards (SPCBs) are responsible for implementation of legislation relating to prevention and control of environmental pollution.

The board has approximately 500 full-time employees including engineers, scientists, and environmental protection specialists.

Functions of CPCB

Functions of CPCB come under both national level and as State Boards for the Union Territories. CPCB, under the Water (Prevention and Control of Pollution) Act, 1974, and the Air (Prevention and Control of Pollution) Act, 1981, aims to promote cleanliness of streams and wells in different areas of the States by prevention, control and abatement of water pollution, and to improve the quality of air and to prevent, control or abate air pollution in the country.

Air quality/ pollution: CPCB runs nationwide programs of ambient air quality monitoring known as National Air Quality Monitoring Programme (NAMP). The network consists of

621 operating stations covering 262 cities/towns in 29 states and 5 Union Territories of the country Under N.A.M.P., four air pollutants viz., Sulphur Dioxide (SO2), Oxides of Nitrogen as NO2, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/ PM10) have been identified for regular monitoring at all the locations. The monitoring of meteorological parameters such as wind speed and wind direction, relative humidity (RH) and temperature were also integrated with the monitoring of air quality. This information on Air Quality at ITO is updated every week.

Water quality/ pollution: Fresh water is a finite resource essential for use in agriculture, industry, propagation of wildlife & fisheries and for human existence. India is a riverine country. It has 14 major rivers, 44 medium rivers and 55 minor rivers besides numerous lakes, ponds and wells which are used as primary source of drinking water even without treatment. Most of the rivers being fed by monsoon rains, which is limited to only three months of the year, run dry throughout the rest of the year often carrying wastewater discharges from industries or cities or towns endangering the quality of our scarce water resources. The inland water quality monitoring network is operating under a three-tier program i.e. Global Environment Monitoring System (GEMS), Monitoring of Indian National Aquatic Resources System (MINARS) and Yamuna Action Plan (YAP).

Urban area programs (EcoCity Program) : CPCB programs for urban areas, also known as EcoCity Program comes under X Plan to improve environment through implementation of identified environmental improvement projects in the selected towns and cities. Pilot studies conducted for urban areas by the Centre for Spatial Environmental Planning created at the CPCB under the World Bank funded Environmental Management Capacity Building Project and supported by the GTZ-CPCB Project under the Indo-German Bilateral Program. According to these studies CPCB develop a comprehensive urban improvement system employing practical, innovative and non-conventional solutions. Under the X Plan, a budget provision of Rs. 15 crores has been made for the period 2002–03 to 2006-07 for the Ecocity projects.

Municipal Solid Waste rules: Every municipal authority comes under the Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW rules, 2000) and responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid. CPCB collects necessary information form municipal authorities and provide them technical assistance.

Noise Pollution/ Rules: According to S.O. 123(E) by MoEFC, various sources like industrial activity, construction activity, generator sets, loud speakers, public address systems, music systems, vehicular horns and other mechanical devices have deleterious effects on human health. CPCB has the responsibility to regulate and control noise producing and generating sources with the objective of maintaining the ambient air quality standards.

Environmental Data Statistics: CPCB manages environmental data statistic in which air quality data and water quality data comes through. In the case of air quality data, it measures

the level of SO2, NO2, RSPM and SPM. CPCB measure and maintains water quality data as well. Quality level of river and ponds are the major fields which comes under the water quality data criteria

2.7 Cleaner production and Clean technology

2.7.1 Cleaner production

Cleaner production can reduce operating costs, improve profitability and worker safety, and reduce the environmental impact of the business. Companies are frequently surprised at the cost reductions achievable through the adoption of cleaner production techniques. Frequently, minimal or no capital expenditure is required to achieve worthwhile gains, with fast payback periods. Waste handling and charges, raw material usage and insurance premiums can often be cut, along with potential risks. It is obvious that cleaner production techniques are good business for industry because it will:

- Reduce waste disposal cost.
- Reduce raw material cost.
- Reduce Health Safety Environment (HSE) damage cost.
- Improve public relations/image.
- Improve company's performance.
- Improve the local and international market competitiveness.
- Help comply with environmental protection regulations.
- On a broader scale, cleaner production can help alleviate the serious and increasing problems of air and water pollution, ozone depletion, global warming, landscape degradation, solid and liquid wastes, resource depletion, acidification of the natural and built environment, visual pollution, and reduced bio-diversity.

2.7.2 Clean technology,

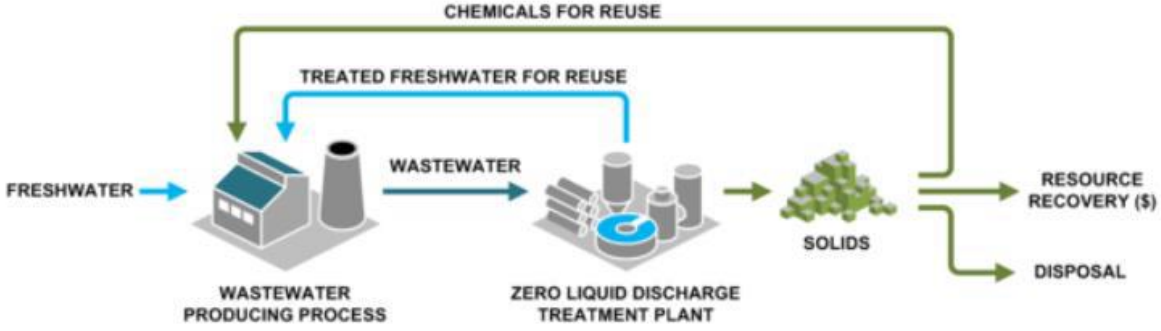
In short cleantech is any process, product, or service that reduces negative environmental impacts through significant energy efficiency improvements, the sustainable use of resources, or environmental protection activities. Clean technology includes a broad range of technology related to recycling, renewable energy, information technology, green transportation, electric motors, green chemistry, lighting, grey water, and more. Environmental finance is a method by which new clean technology projects that has proven that they are "additional" or "beyond business as usual" can obtain financing through the generation of carbon credits. A project that is developed with concern for climate change mitigation is also known as a carbon project.

Clean Edge, a clean technology research firm, describes clean technology "a diverse range of products, services, and processes that harness renewable materials and energy sources, dramatically reduce the use of natural resources, and cut or eliminate emissions and wastes." Clean Edge notes that, "Clean technologies are competitive with, if not superior to, their conventional counterparts. Many also offer significant additional benefits, notably their ability to improve the lives of those in both developed and developing countries

2.8 Closing the Loop System

- Businesses use all kinds of terms to prove they're environmentally friendly. "Recyclable," "plant-based and "energy efficient" all get tossed around a lot — and while most people generally know what those words mean, there's one frequently used phrase that's harder to decipher: closed-loop system.
- When a company says it uses a closed-loop system, it's referring to its supply chain. Under a closed-loop system, businesses reuse the same materials over and over again to create new products for purchase. It's a way to conserve natural resources and divert waste from the landfill, and increasingly, more companies are adopting it.
- The phrase "closed-loop system" is often paired with "circular economy," which is "an industrial system that is restorative and regenerative by intention or design," to use the World Economic Forum's definition. It's helpful to think of literal loops or circles to understand the core concept. Instead of raw materials moving in a straight line from collection, through manufacturing, to purchase (and, once it's broken or used up, the trash can), imagine a loop. The materials are always moving through this loop, never reaching an endpoint
- When a product has served its purpose, it restarts at collection. Someone pares the item back down to scraps, providing "new" raw materials. Then it's manufactured into a finished product yet again, one the consumer can then purchase.
- Think of aluminium cans. When you finish drinking a beverage out of a can, you put it in a recycling bin. Factories salvage the aluminium and make another can that is shipped to a store, where anyone can buy it. The process can be repeated thousands of times.
- Closed-loop systems can be applied to all kinds of industries. Take the beer business. Sierra Nevada has closed the loop in the company's Chico, California facilities, where the beer makers compost waste generated from the brewery into soil used to grow new barley and hops.
- But that's far from the only example. Companies like For Days are fighting the concept of fast fashion with closed loop clothing. When customers sign up for a For Days subscription, they receive a bundle of shirts, ranging from basic tank tops to sweatshirts. Once the clothes are worn down, stained, or torn, subscribers send them back for a new set — derived directly from those used threads.

2.9 Zero-liquid Technologies



Zero-liquid discharge (ZLD) is a water treatment process in which all wastewater is purified and recycled; therefore, leaving zero discharge at the end of the treatment cycle. Zero liquid discharge is an advanced wastewater treatment method that includes ultra filtration, reverse osmosis, evaporation/crystallization, and fractional electrode ionization

Clarifier and or a reactor: Essential step to precipitate out hardness, silica salts and metals
Biological process: Decomposition of organic waste using microbes; according to the COD/BOD ratio, biological processes like activated sludge, Soil biotechnology treatment, Membrane Aerated Biofilm Reactor, Anaerobic Digestion, can be employed
Chemical feed: Precipitation, Flocculation, Disinfection and Coagulation need chemicals as precursors for the removal of metals and other suspended solids.
Filter: Concentration of secondary solid waste can be done after pre-treatment alongside with an evaporator
Filtration: It is essential for the removal of suspended solids according to the size of the particles and helps prevent fouling, scaling and unnecessary eroding or corrosion down the line of treatment. Filtration includes Microfiltration, Ultra filtration, Nano-filtration.
Reverse osmosis: Removes dissolved stubborn solids from the stream from the primary and secondary stages of concentration
Brine concentration: Further concentration of the stream occurs, helps in reduction of the waste volume
Evaporator: Final stage of concentrating the liquid counterpart of the stream before crystallization.
Crystallizer: Presents the dry solid waste cake which can be readily disposed off, it is devoid of any liquid
Ultra-filtration: It is used for the separation of suspended solids, colloidal particles, and large size microorganisms from the liquid effluent.

2.10 Recommended questions

1. Enumerate the various Environmental Quality objectives. Briefly explain any two
2. Distinguish between: i) Pollution control and Pollution Prevention.
   ii) Concentration and Mass Standards
3. Briefly explain on Cleaner production and lean technology.
4. Briefly explain on Zero discharge technologies.

2.11 Outcomes

Appreciate the elements of Corporate Environmental Management systems complying to international environmental management system standards.

2.12 Further Reading

1. https://petrosep.com/zero-liquid-discharge-systems/
2. http://environmentclearance.nic.in/writereaddata/EIA/01012015TOEFB6H2Annexure-DocumentofEMP.pdf

Module – 3
Environmental Management System

Structure

3.0 Introduction

An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency. This site provides information and resources related to establishing an EMS for small businesses and private industry, as well as local, state and federal agencies. The EPA continues with its progress in developing and maintaining an environmental management system at each of its offices, laboratories, and other facility operations, focusing on the reduction of the agency's environmental footprint.

3.1 Objectives

This course will enable students to gain knowledge in Environmental protection and Management systems

3.2 Environmental Management System (EMS)

An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating efficiency.

Basic Elements of an EMS include the following:

- Reviewing the organization's environmental goals;

- Analyzing its environmental impacts and compliance obligations (or legal and other requirements);
- Setting environmental objectives and targets to reduce environmental impacts and conform with compliance obligations;
- Establishing programs to meet these objectives and targets;
- Monitoring and measuring progress in achieving the objectives;
- Ensuring employees' environmental awareness and competence; and,
- Reviewing progress of the EMS and achieving improvements

The five main stages of an EMS, as defined by the ISO 14001 standard

1. Commitment and Policy - Top management commits to environmental improvement and establishes the organization's environmental policy. The policy is the foundation of the EMS.

2. Planning - An organization first identifies environmental aspects of its operations. Environmental aspects are those items, such as air pollutants or hazardous waste, that can have negative impacts on people and/or the environment.

3. Implementation - An organization follows through with the action plan using the necessary resources (human, financial, etc.). An important component is employee training and awareness for all employees (including interns, contractors, etc.

4. Evaluation - A company monitors its operations to evaluate whether objectives and targets are being met. If not, the company takes corrective action.

5. Review - Top management reviews the results of the evaluation to see if the EMS is working. Management determines whether the original environmental policy is consistent with the organization's values.

Top 10 Components in a Successful Environmental Management System

For maximum environmental and economic benefits from an environmental management system and to help comply with the EMS requirement under the Toxics Use & Hazardous Waste Reduction law, a business should include the following 10 components in its system. These components can apply to many different EMS models, including ISO 14001. Use this checklist to be sure your system includes all 10 and keep it on site.

1. Environmental Policy

- Reflects how the organization feels about the environment
- Identifies environmental impacts of processes and products
- Ensures compliance with environmental requirements
- Commits organization to prevent pollution, reduce environmental risks and share information with external stakeholders

2. Environmental Requirements and Voluntary Initiatives

- Employees understand their roles in meeting environmental requirements
- Identify management and manufacturing practices that affects the organization's ability to meet requirements
- Identify and work with programs that encourage preventing pollution

3. Objectives/Targets

- Set the following environmental objectives: comply with environmental requirements; continuous improvement in regulated and non-regulated areas; prevent pollution
- Make objectives specific to the organization Set timeframes to meet objectives
- Update objectives as environmental requirements evolve

4. Structure, Responsibility and Resources

- Ensure the organization has the personnel and resources needed to meet objectives
- Make managers responsible for the environmental performance of their unit
- Develop procedures for attaining objectives

5. Operational Control

- Establish a procedure to ensure the proper waste management hierarchy is followed
- Develop simple procedures to measure and report environmental impacts of processes and products

6. Corrective and Preventive Action and Emergency Procedures

- Document procedures for identifying, correcting and preventing mistakes
- Develop emergency procedures to minimize or eliminate adverse environmental impacts associated with accidents or emergencies
- Correct causes of potential hazards to prevent pollution

7. Training, Awareness and Competence

- Train staff whose roles affect meeting objectives, and make certain staff are capable of carrying out required duties
- Mandatory trainings include detailed pollution prevention methods

8. Organizational Decision-making and Planning

- Use life-cycle analysis to identify the impact products make on the environment
- Empower all employees to make pollution prevention improvements that do not require significant resources

9. Document Control

- For future evaluation, document steps taken to meet objectives Use electronic documentation to improve record management
- Document all pollution prevention suggestions

10. Continuous Evaluation and Improvement

- Conduct and document periodic objective-based audits of the organization's performance
- Use audits to assess pollution prevention efforts

3.3 EMAS

The EU Eco-Management and Audit Scheme (EMAS) is a premium management instrument developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance. EMAS is open to every type of organisation eager to improve its environmental performance. It spans all economic and service sectors and is applicable worldwide.

ISO 14000 is a family of standards related to environmental management that exists to help organizations

a) Minimize how their operations (processes, etc.) negatively affect the environment (i.e. cause adverse changes to air, water, or land);
b) Comply with applicable laws, regulations, and other environmentally oriented requirements;
c) Continually improve in the above

ISO 14001 standard provides a systematic framework for integrating environmental management practices by supporting environmental protection, pollution prevention, waste minimisation, as well as energy and materials consumption reduction.

3.4 ISO 14000

ISO 14000 is a series of internationally recognized standards for structuring an organisation‘s EMS and managing the environmental performance of the system to induce environmental improvement and cost savings. The series of standards are managed by the International Organisation for Standardization (ISO). There are 22 standards, guides, technical reports and documents under development of which 16 have were released as of December 2005. These documents, illustrated in Figure 2.1, address the following subjects:

- EMS (ISO 14001, ISO 14004 and ISO/TR 14061).
- Environmental Auditing and EMS Auditing (ISO 19011).
- Guidelines for Environmental Auditing – Audit Pro-grammes, Reviews & Assessments (ISO 14015).
- Environmental Labelling (ISO 14020 and ISO 14021).
- Environmental Labelling – Practitioner Programmes
- Guiding Principles, Practices and Certification Procedures of Multiple Criteria Programmes (ISO 14024 and ISO/TR 14025).
- Environmental Performance Evaluation (ISO 14031 and ISO/TR 14032).
- Environmental Management through Life Cycle Assessment (ISO 14040, ISO 14041, ISO 14042, ISO 14043, ISO/TR 14047, ISO/TS 14048 and ISO/TR 14049).
- Vocabulary of Environmental Management Terms (ISO 14050).
- Guide for the Inclusion of Environmental Aspects in Product Standards (ISO 14062).

3.5 EMS as per ISO 14001

The definition of an EMS used by ISO 14001 is: ―The part of the overall management system that includes organisational structures, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing achieving, reviewing and maintaining the environmental policy. The International Organization for Standardization (ISO) developed an international standard, ISO 14001, to specify requirements for environmental management systems. According to ISO, more than 300,000 organizations in 171 countries have certified to ISO 14001, including more than 3,800 companies in the Unites States.

The standard was revised in 2015. As part of the development process, ISO conducted a continual improvement survey to develop an understanding of the needs of current, past, and potential users.

The purpose of the ISO 14001 management system standard is to specify general requirements and guidelines that, when followed, should provide reasonable assurance that the outputs from the system will have minimal negative environmental impact and improved environmental performance. It should be noted that the ISO 14001 standard is non prescriptive; that is, it details what should be done, not necessarily how to do it.

The ISO 14001 standard is developed around the plan-do-check-act (PDCA) model of improvement, an iterative process that must be applied regularly to ensure benefits are being realized and the standard is being upheld. The primary operational components of an ISO 14001 EMS can be grouped as follows:

Create/update environmental policy.

Plan:

- Environmental aspects
- Legal and other requirements Objectives, targets, and programs

Do:

- Resources, responsibilities, and authority Competence, training, and awareness Communication
- Documentation Control of documents Operational control
- Emergency preparedness and response

Check:

- Monitor and measure Evaluate compliance
- Nonconformity, corrective and preventive action Control of records
- Internal audits

Act:

- Management review
- ISO 14001 audit

3.5.1 Benefits and barriers of EMS

Organisations certified to ISO 14001 demonstrate their commitment to continuous improvement and reduced environmental impact

The certificate can significantly improve your bargaining position when taking part in public and private green procurement tenders. As consumers are becoming increasingly aware of environmental and ecological issues, ISO 14001 certification helps your brand stand out as a responsible provider

Companies that implement the ISO 14001 EMS aim to minimize wastage, from materials to energy consumption, throughout the supply chain and can thereby reduce cost

Potential Benefits

- Improved environmental performance
- Enhanced compliance
- Pollution prevention
- Resource conservation
- New customers/markets

- Increased efficiency/reduced costs
- Enhanced employee morale
- Enhanced image with public, regulators, lenders, investors
- Employee awareness of environmental issues and responsibilities

Barriers associated with EMS's In 1999, the Department of Enterprise, Trade and Employment stated that the majority of companies accredited to ISO 14001 in Ireland at that time were large indigenous organisations or the subsidiaries of large multi-national corporations. Many of these certified companies are now examining the environmental performance of their downstream suppliers, many of them Small Medium Enterprises (SME's), and ultimately may require them to become certified to ISO 14001. In many cases the SMEs themselves are anxious to demonstrate environmental probity by adopting and implementing environmental management system standards, but are reluctant to do so for the following reasons

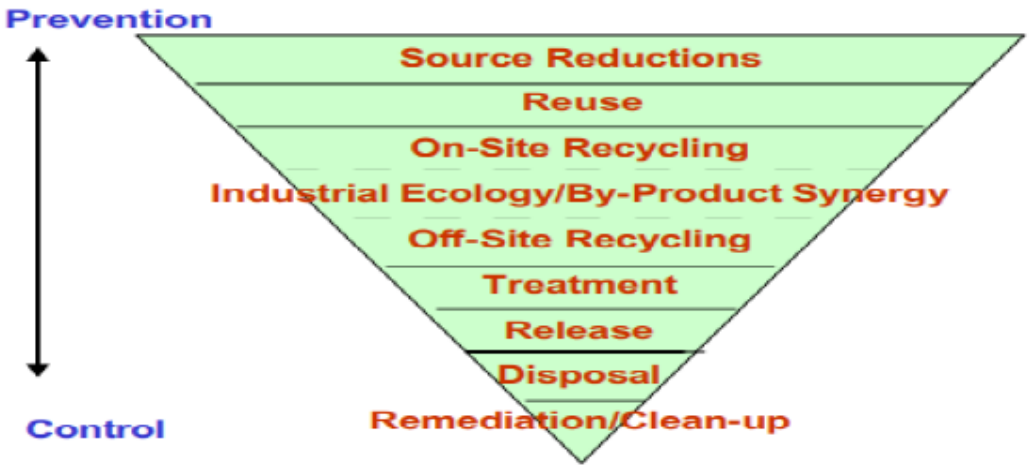
- Fear of the unknown
- Lack of resources
- Lack of technical expertise
- More pressing business imperatives
- Lack of direction
- Fear of failure.

3.6 Concept of continual improvement and pollution prevention

Pollution prevention is generally defined as "the use of processes, practices, materials, products or energy that avoids or minimizes the creation of pollutants or wastes at the source."

The strategic planning framework identifies an opportunity to "continuously improve air quality by minimizing the use of polluting processes, practices, materials and products,

Which is the broad definition used by the project team in its work.



Pollution prevention techniques and practices focus on:

- Substances of concern
- Materials and feedstock substitution

- Operating efficiencies
- On-site reuse and recycling
- Training
- Purchasing practices
- Product design
- Equipment modifications
- Product reformulation
- Process changes
- Clean production
- Avoidance of cross-media transfer of pollutants or waste
- Life-cycle assessment

Examples of Pollution Prevention Techniques and Practices Materials and feedstock substitution are a method of source elimination. Polluting materials in a production process or embedded in a product are replaced with less polluting or non polluting substances. Opportunities for materials and feedstock substitution include:

- Painting applications
- Parts cleaning
- Metal finishing
- Printing operations
- Building and grounds maintenance
- Operating efficiencies and training are examples of how normal parts of good operation can provide effective ways to prevent pollution. Examples include:
- Changing production schedules to minimize equipment and feedstock changeovers
- Improving maintenance schedules
- Segregating by-products at the source
- Training staff to improve material handling and recognize P2 opportunities

Product design and reformulation includes methods for preventing pollution associated with the entire life cycle. Addressing environmental concerns at an early stage can avoid environmental impacts throughout the product life cycle in a cost-effective manner. Results of redesigning or reformulating a product include:

- Reducing toxicity of a product
- Reducing waste material
- Extending the life of a product
- Extending the life of the materials used
- Reducing energy and material intensity needed to produce, use and dispose of the product

Equipment modifications and process changes involve new technologies or approaches to existing operating systems processes and practices to improve production efficiencies and reduce pollution and waste. An example is mechanical stripping instead of using solvents to remove paint and varnish

The Value of Waste can also be viewed as a loss of valuable process materials that could have economic and environmental benefits if reused or recycled. The following approaches reflect this perspective on the value of waste

On-site reuse and recycling is considered pollution prevention because it occurs at the same place as the original activity.4 Reuse means using materials again in their original form or in new applications. Recycling extends the effective life of resources. Environmentally sound recycling is usually preferable to end-of-pipe solutions. Raw materials, chemicals and treated and untreated wastewater are examples of materials that could be reused or recycled. Some examples of reuse and recycling are:

- Recovering metals by ion exchange or reverse osmosis
- Recycling cooling water
- Reusing trim and cuttings from plastic moulding in on-site production rather than taking them for off-site disposal

3.7 Environmental policy

Environmental policy is the commitment of an organization or government to the laws, regulations, and other policy mechanisms concerning environmental issues.

These issues generally include air and water pollution, waste management, ecosystem management, maintenance of biodiversity, the management of .natural resources, wildlife and endangered species

For example, concerning environmental policy, the implementation of an eco-energy-oriented policy at a global level to address the issues of global warming and climate changes could be addressed.

Policies concerning energy or regulation of toxic substances including pesticides and many types of industrial waste are part of the topic of environmental policy. This policy can be deliberately taken to influence human activities and thereby prevent undesirable effects on the biophysical environment and natural resources, as well as to make sure that changes in the environment do not have unacceptable effects on humans.

The first step in creating an EMS is to perform an Initial Environmental Review. This tells you where you are and creates a road map for your organization. There are four main areas:

- Review previous environmental issues.
- Consider any regulations which have operational impact.
- Identify and evaluate possible environmental issues in your organization.
- Outline current operations and how are they managed; also consider indirect impacts.

3.8 Initial environmental review

The IER is the first step in the implementation of an EMS - where a business considers all the factors affecting its 'relationship' with the environment. It should form the baseline and foundation for the other parts of your EMS.

Your IER should enable you to:

- Identify how existing site operations have an environmental impact - eg the impact of normal operating conditions, abnormal conditions and emergency situations

- Establish which of these impacts are significant and need improvement by setting objectives and targets
- Identify breaches or potential breaches of environmental legislation
- Identify relevant EMS documentation which needs to be put in place
- Quantify emissions, discharges, and material and utility use
- Identify opportunities for improving performance and minimising waste
- Evaluate previous emergency situations and accidents
- Develop your environmental policy

3.9 Environmental aspect and impact analysis

Environmental Aspects

According to of ISO 14001:2004, an environmental aspect is any "element of an organization's activity, products or services that can interact with the environment." Goetsch & Davis (2001) state: In simple terms an environmental aspect is anything resulting from the organization's activities, products or services that has the potential to cause an environmental impact, even if it is presently controlled, or prevent such impact. The fact that the potential exists (if something goes wrong, for instance) makes it an environmental aspect (p. 18). An environmental aspect can be either negative or positive. Negative aspects include emissions to the air or water, discharge of oil to the land or water, generation of hazardous waste, generation of solid waste, community impact, and the generation of dust and noise. Positive aspects include recycling of used materials such as steel, aluminum, copper, glass bottles and paper, removal of pollutants from the air or water, and restoring land by removing decontaminated soil.

Environmental Impact

In cause and effect, if one considers an environmental aspect to be the cause, then the environmental impact is the effect. An environmental impact is any change to the environment, whether adverse or beneficial, wholly or partially resulting from the organization's activities, products or services. Essentially, the environmental impact is the result of the environmental aspect. For example, suppose a company is discharging wastewater

3.10 Legal and other requirements

3.10.1 Legal requirements include:

- National, regional and local requirements.
- Standards in locations where an organisation sells prod-ucts/services.
- Permit conditions.
- Regulatory obligations.

Other requirements might include (for example):

- Organisation-specific codes.
- International Chamber of Commerce (ICC) Charter for Sustainable Development.

Other industry codes or programmes to which the organi-sation voluntarily subscribes (e.g. UNEP declaration for the banking and insurance sector, Responsible Care Programme for the Chemical Industry, and others).

Identifying applicable regulations, interpreting them, and determining their impacts on organizations operations can be a time consuming task.

Even though small organisations usually do not have an in-house lawyer, they can deal with environmental legal compliance at a reasonable cost. For a start, organisations often have some important resources such as:

- Internal expert(s) who are very familiar with operations.
- Written documentation of operations and activities.
- Contact with authorities.

3.10.2 Objectives and targets

Both ISO 14001 and EMAS require the environmental policy to state a commitment to continuous improvement. This process can only be controlled by establishing a set of environ-mental targets and objectives. These targets and objectives can only be effective when they are specific enough to be audited, meaning all targets need to be quantified and measurable.

Setting objectives requires an analysis of the exposure to different environmental aspects:

- Environmental aspects which have high public priority and to which the organisation contributes heavily. Here environmental objectives should be set.
- Environmental aspects which have low public priority and to which the organisation contributes heavily. These aspects will have an impact on an organisation if public priority changes (e.g. due to new scientific knowledge, accidents, etc.). Therefore the objective should be to keep an eye on possible changes in public perception and hence, priorities, and to prepare alternatives.
- Environmental aspects which have high public priority and to which the organisation has a low contribution. These objectives should be added to the above if any in-vestments or changes in technology (products and production processes) are planned. Due to the high public priority the objective should be to hold the current position by not contributing more to these problems.

The objectives previously set can be used later on to evaluate the environmental performance of the organisation. This is done by comparing the current state to the target level set by the environmental objectives and targets. Once this is done top management should set a time frame in which the objectives are to be achieved. This involves evaluating the environmental objectives according to their importance for the organization.

3.11 Environmental management programs

Environmental management programs support the NIEHS Environmental Policy and the overall goal of reducing negative environmental impacts. These programs were established to assure compliance with federal, state, and local environmental regulations. Each program

includes specific requirements that are documented in the NIEHS EMS Manual as well as a corresponding written plan, procedure, or instruction

1. **Air Emissions:** This program includes performance standards for the boilers, emergency generators and incinerators located on the NIEHS Campus. This program also encourages and supports alternative transportation including bus, carpool, and telework options.

2. Energy Management: This program seeks to reduce electricity consumption associated with NIEHS laboratory, utility, office, and outdoor operations and support HHS/NIH agency wide efforts to reduce campus building energy intensity and increase usage of renewable energy.

3. Green Purchasing: This program encourages the purchase of recycled content materials, energy-efficient equipment, alternative fuelled vehicles, bio-based products, environmentally preferable products, and non-ozone depleting substances.

4. Hazardous Materials Management: The program provides criteria for the safe and environmentally sound storage, handling, transportation and disposition of hazardous materials used in laboratory research, support and maintenance operations, and construction activities.

5. Pesticides: This program follows integrated pest management (IPM) principles when controlling pests in the animal facilities, inside campus buildings, and on campus grounds through limited pesticide application in a manner that is effective yet safe for the environment, personnel, and research activities.

6. Solid Waste Management: This program insures that solid wastes are identified, classified, collected, transported, stored, recycled, treated and/or disposed safely and in a manner protective of human health and the environment. Maximization of the quantity of material diverted from the landfill, either by recycling, reuse, or reduction in quantities used, is a primary objective.

7 .Storm water Management: This program focuses on reducing the potential for outdoor petroleum and chemical spills, and minimizing the impact of construction projects on the storm water conveyance system.

8. Wastewater: This program reduces the potential for pollutants to enter the sanitary sewer system through effective pre treatment, source reduction, proper chemical disposal, and other wastewater management programs.

9. Water Consumption: This program seeks to reduce water consumption associated with NIEHS laboratory, utility, facility, and domestic operations.

Structure and Responsibility

Organizational structure outlines the hierarchy and reporting relationships between various functions and levels in an organization. Duties at each level of responsibility and functional area may be summarized in a more detailed organization chart

Management's Responsibilities Top management has the responsibility to:

- Define the environmental policy for the organization
- Lead by example in their commitments to continual improvement, prevention of pollution, and compliance with relevant environmental legislation and regulations
- Authorize adequate resources to implement and maintain the EMS
- Reward good performance in the EMS
- Conduct regular management reviews of the EMS
- Integrate environmental management principles and practices into the organizational culture.

Awareness

- People accept responsibility more readily if they understand why their actions are important
- People become self-motivated, so less reinforcement by management is required
- Emphasizes that environmental protection is everyone's responsibility
- Helps to generate commitment by employees

Competence

- The application of knowledge, understanding, judgments, and skill to consistently carry out an activity effectively and efficiently to a pre-set standard
- The objective of training should be to develop competence, or the means to attain competence

3.12 Training awareness and competence communication

EMS training is basically intended ―to explain the importance of the EMS to staff, and to explain their responsibilities for EMS operations‖ [Martin, R. 1998, p. 48]. Adequate training is essential for employees and all levels of management to fully understand their responsibilities. Passive management support is often caused by management's ignorance about the EMS. Executives need to understand both their own responsibilities and their employees 'responsibilities.

Training of all employees is very important because every employee:

- Can have potential impacts on the environment through his or her daily activities.
- Can be a useful resource for generating ideas about establishing operational control for a process, defining environ-mental aspects or defining structural responsibilities.

All staff members should be trained according to their specific environmental responsibilities. Too much training may confuse employees and is not cost-effective. Training should be carried out in direct relation to significant aspects, targets and objectives in the EMS. It needs to be made sure that all employees understand the potential

consequences of not following the EMS, as well as the positive effects of following the EMS. If they do not have significant roles, the employees should at least be trained on EMS content and purpose. Training should be planned around existing meetings to keep the financial expenses for training as low as possible.

Training must take place when:

- New employees are hired.
- A change in job descriptions takes place.
- The corrective action process notes failure to follow instructions.
- New procedures are introduced or already existing procedures are altered.
- EMS aspects/objectives/targets have changed.
- New regulations are introduced.
- Job performance is unacceptable

Key Steps in Developing a Training Programme:
Step 1: Assessment of training needs & requirements.
Step 2: Defining training objectives.
Step 3: Selecting suitable methods and materials.
Step 4: Preparing training plan.
Step 5: Conducting training.
Step 6: Tracking of training (and maintaining records).
Step 7: Evaluating training effectiveness.
Step 8: Improving training programme

Internal and External Communication

Stakeholders usually show great interest in the environmental performance and management efforts of an organisation. An effective EMS requires this information to be communicated both internally and externally.

Internal communication is the communication within a facility or organisation that is directly related to the EMS. It is required to establish communications on and between all relevant levels of functions within the organisation. External communication is the communication between the organisation and interested parties outside the organisation. There are numerous benefits resulting from effective communications.

Internal communication will:

- Motivate the workforce.
- Gain acceptance for management‘s plans and efforts.
- Explain the environmental policy and the EMS and how they relate to the overall organisational vision.
- Ensure understanding of roles and expectations.
- Demonstrate management commitment.
- Monitor and evaluate performance.
- Identify potential system improvements.

Effective external communication will:

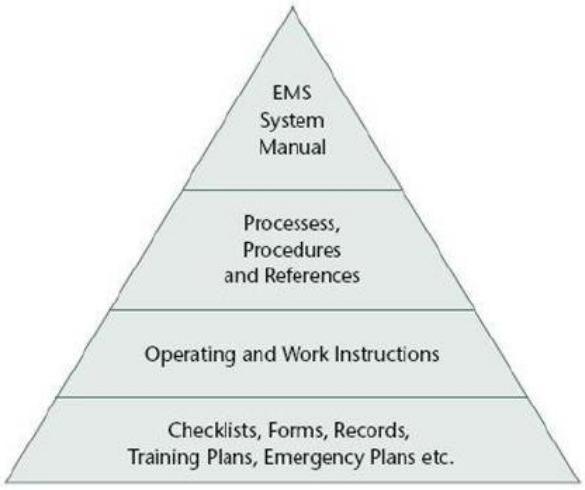
- Demonstrate management‘s commitment to the environment.
- Make others aware of the organisation‘s environmental policy and commitment to environmental responsibility.
- Address concerns about the organisation‘s environmental activities by external parties.
- Announce the organisation‘s strategic environmental man-agement approach.
- Establish a line of communication that clearly defines emergency responsibilities

3.13 Documentation and document control

EMS documentation consists of:

- The environmental policy.
- The organisational structure and key responsibilities.
- A description or summary of how an organisation satisfies EMS requirements (e.g. ―How do we identify environ-mental aspects? ―How do we control documents? and ―How do we comply with legal requirements?‖).
- System-level procedures (e.g. procedures for corrective actions).
- Activity or process-specific procedures/work instructions.
- Other EMS-related documents (such as emergency response plans, training plans, etc.).

When undertaking a new activity like EMS development, documenting discussions, plans, targets, and programmes is crucial. Documentation ensures that no information is lost, and enables performance to be tracked. It ensures that the EMS is well understood and operating as designed. However, adequate information must be provided to the people doing the work. There also may be external parties that want to understand how the EMS is designed and implemented, such as customers, regulators, lending institutions, registrars and the public. For these reasons, the various processes that make up an EMS should be documented.



An organisation‘s staffs are not able to consistently perform their jobs in the right way unless they are provided with the proper tools. These tools include all EMS related

documents, such as the environmental policy, objectives and targets, information about roles responsibilities and authorities, a description of the EMS, procedures on the system-level and process or activity-level, and emergency response plans. Without a mechanism to manage these EMS documents, an organisation cannot be sure that people are working with the right documents. To ensure that everyone is working with the proper EMS documents, every organisation should have a procedure that describes how such documents are controlled. Implementation of this procedure should ensure that:

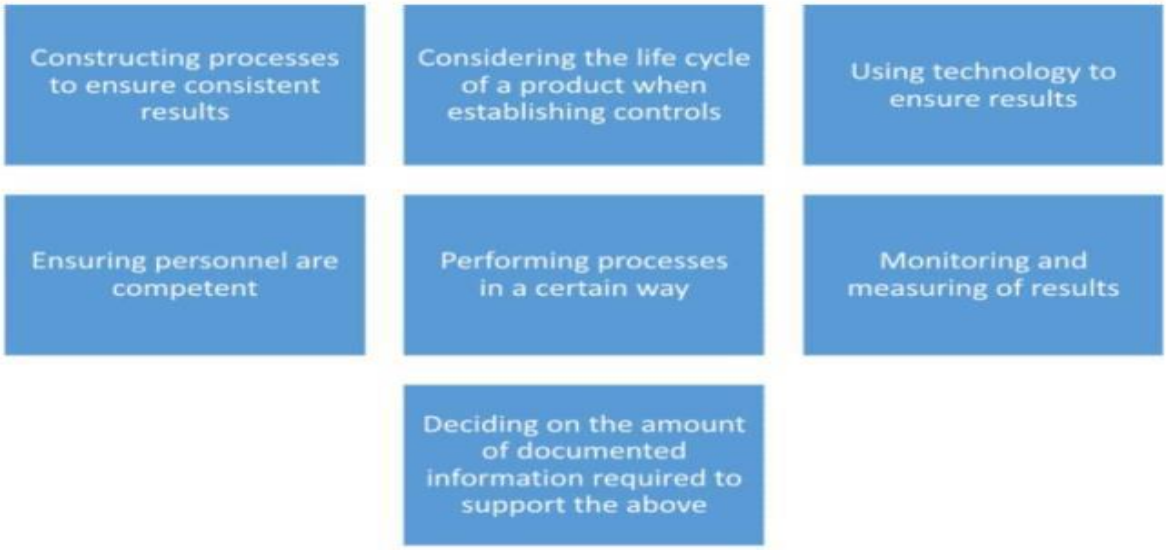
- EMS documents can be located.
- They are periodically reviewed.
- Current versions are available where needed.
- Obsolete documents are removed

3.14 Operational controls

The standard states that the methods defined to ensure operational control will be dependent on the organization's activities, legal obligations, and significant operational controls.

Therefore, an organization must decide how to construct and combine processes to ensure that total operational control of its environmental aspects is achieved. These methods of defining and implementing controls may include

- Constructing processes to ensure consistent results
- Considering the life cycle of a product when establishing controls
- Using technology to ensure results
- Ensuring personnel are competent
- Performing processes in a certain way
- Monitoring and measuring of results
- Deciding on the amount of documented information required to support the above



Methods of defining and implementing ISO 14001 operational controls

3.15 Monitoring and Measurement

- The organization must monitor, measure, analyze and evaluate its environmental performance.
- It must determine what needs to be monitored and measured and as applicable the methods for monitoring, measurement, analysis, and evaluation to ensure valid results.
- It must determine the criteria against which environmental 'performance and its appropriate indicators will be evaluated.
- It must also determine when the monitoring and measuring shall be performed and when the results from monitoring and measurement will be analyzed and evaluated.
- The organization must ensure that calibrated or verified monitoring and measurement equipment is used and maintained, as appropriate.

The organization must also evaluate its environmental performance and the effectiveness of the environmental management system

When determining what should be monitored and measured, In addition to progress on environmental objectives, the organization should take into account its significant environmental aspects, compliance obligations, and operational controls.

The methods used by the organization to monitor and measure, analyze and evaluate should be defined in the environmental management system, in order to ensure that:

- The timing of monitoring and measurement is coordinated with the need for analysis and evaluation results
- The results of monitoring and measurement are reliable, reproducible and traceable;
- The analysis and evaluation are reliable and reproducible and enable the organization to report trends.

Monitoring and measurement help you:

- Evaluate environmental performance;
- Analyze the root causes of problems;
- Assess compliance with legal requirements;
- Identify areas requiring corrective action, and,

Improve performance and increase efficiency. In short, monitoring and measurement help you manage your organization better. The results of pollution prevention and other efforts are easier to demonstrate when current and reliable data are available. These data can help you demonstrate the value of the EMS to top management. Your organization should develop means to:

- Monitor key characteristics of operations and activities that can have significant environmental impacts and/or compliance consequences;
- Track performance (including your progress in achieving objectives and targets);
- Calibrate and maintain monitoring equipment; and,
- Through internal audits, periodically evaluate your compliance with applicable laws and regulations.

3.16 Management review

Carry out an EMS management review

Guide

A management review is the final element of the environmental management system (EMS) process. It involves a formal evaluation of the adequacy of your business' EMS - taking into account any new environmental issues, legislation, changing circumstances and continual improvement.

Management review meetings should be attended by individuals with either executive or specialist responsibility, for example:

- The site director
- The management representative
- Line managers with specific environmental responsibilities

In these meetings, the management representative should give the results of any recent audits to senior management and present a written report detailing audit findings.

The management review should cover:

- Environmental performance and progress in achieving objectives and targets
- Compliance with legislation
- Results of internal audits and reports
- Actions required as a result of non-conformances
- New processes and any changes to known environmental issues

Any changes in circumstances - for example changes in legislation or new technology

- The effectiveness of training
- The need for any revisions to your environmental policy, objectives and targets
- Follow-up actions from previous management reviews

3.12 Recommended Questions

1. Define environmental policy, write the benefits of developing environmental policy.
2. What is initial environmental review? Give its benefits
3. Explain Emission and ambient Standards
4. Explain environmental management programs
5. Explain EMS and EMAS
6. Explain Effluent and stream standards
7. With a neat sketch, explain the components of EMS.
8. Explain objectives and targets.
9. Explain Environmental aspects and impact analysis

3.13 Outcomes

Appreciate the elements of Corporate Environmental Management systems complying to international environmental management system standards.

3.14 Further Reading

- https://www.iso.org/iso-14001-environmental-management.html
- https://www.casahome.org/attachments/2002_Pollution_Preventions_Continuous_Improvement_Framework.pdf

Module – 4
Environmental Audit

Structure

4.0 Introduction

Environmental auditing is essentially an environmental management tool for measuring the effects of certain activities on the environment against set criteria or standards. Depending on the types of standards and the focus of the audit, there are different types of environmental audit. Organisations of all kinds now recognise the importance of environmental matters and accept that their environmental performance will be scrutinised by a wide range of interested parties

4.1 Objectives

- To serve to achieve compliance standards and establish a report with regulatory bodies
- To review the implementation of policies

4.2 Environmental management system audits as per ISO 19011

ISO 19011 is defined as the standard that sets forth guidelines for auditing management systems. The standard contains guidance on managing an audit program, the principles of auditing, and the evaluation of individuals responsible for managing the audit programs. An audit program consists of the arrangements made to complete all of the individual audits needed to achieve a specific purpose.

ISO 19011:2018 provides valuable information on how to improve an audit program systematically, just as other departments in an organization are expected to improve. One aspect of such improvement is continuously ensuring the audit program objectives are in line with the management system policies and objectives. Organizations, in pushing for auditing improvements, should consider the needs of customers and other interested parties.

An area of increasing importance in auditing management systems and business in general is the concept of risk. As of the 2011 edition, risk has been integrated throughout the audit program management section of the ISO 19011:2018 standard.

ISO 19011 offers guidance on every step of auditing a management system or audit program, including:

Defining program objectives

- Ensuring you understand the specific objectives you hope to achieve
- Making audit arrangements
- Assigning roles and responsibilities
- Defining number, scope, location, and duration of audits
- Determining criteria and specific checklists
- Establishing review procedures

Completing the audits needed

- Planning and reviewing internal documents
- Collecting and verifying audit evidence
- Generating findings and preparing reports
- Communicating findings

Reviewing the results and process

- Assessing results and trends
- Conforming with audit program procedures
- Evolving needs and expectations of interested parties
- Analyzing audit program records
- Examining effectiveness of the measures to address risks
- Ensuring confidentiality and information security

4.3 Roles and qualifications of auditors

4.3.1 Roles of Auditors

An environmental auditor needs several years of experience in environmental compliance or a bachelor's degree in one of the following:

Environmental Science
Environmental Management
Natural Resource Management
Environmental Engineering
Environmental Assessment

- Professional certification as a Certified Environmental Auditor is available from the National Registry of Environmental Professions.
- Applicable certifications include:

Environmental Professional – Compliance Environmental Auditor (EPCEA)
Environmental Professional – Environmental Management Systems Auditor (EPEMSA)
Certified Environmental Auditor (CEA)

- Additional Education for Environmental Auditors

While you can begin a career as an environmental auditor with a bachelor's degree or experience in a related field, some employers may require a master's degree and/or certification to be considered for the position. Certification or a master's degree can also be beneficial to advancing into senior level or management positions in the field.

As an environmental auditor, they will be responsible for the regular auditing of all environmental policies and procedures. This involves working with an audit team and with staff to get a good picture of how environmental compliance is being handled. Auditors will be responsible for:

- Selecting and managing the audit team
- Reviewing the operations of the business being audited and determining how environmental issues are being handled
- Gathering data on the business operations through on-site inspections, document reviews, staff interviews, and other methods
- Check business records for governmental permits and requirements, safety standards, maintenance, and inventory control measures
- Review emergency preparedness and response procedures
- Review management systems, environmental monitoring programs and waste management efforts
- Review employee training procedures and programs and the work environment for compliance with government and corporate standards
- Write and compile final audit reports including results of the audit and recommendations for changes and improvement
- Present the audit findings to the business managers and directors
- Assist in the development of an environmental management plan
- Follow up at a future time to ensure improvements and recommendations have been successfully implemented.

4.3.2 Qualifications of auditors

The auditors should have a relevant degree or diploma and completed a minimum of four years of work experience in a technical, professional or managerial position involving the exercise of judgment and decision-making skills**.**

In addition to the four years of work experience they need to demonstrate a satisfactory level of work experience gained within an environmental context relevant to their level of education. The four years of work experience in a technical, professional or managerial position may have been concurrent with the work experience within an environmental context.

Skills and Knowledge

Auditors shall through education, training and/or work experience and auditing experience be able to demonstrate a satisfactory level of competence in all of the following areas:

- Environmental science and technology
- Technical and environmental aspects of facility operations
- Relevant requirements of environmental laws, regulations and related documents

- Environmental management systems and standards against which audits may be performed
- Audit procedures, processes and techniques
- Communication skills – written and oral

4.4 Environmental performance indicators and their evaluation

Environmental performance indicators (EPI)

The standard identifies two categories of EPI — operational performance indicators (OPIs) and management performance indicators (MPIs). A third category — environmental condition indicators (ECI) — measures how an organization's activities, products and services interact with the natural environment at a local, regional, national or global level. ISO 14031 provides guidance on the selection of indicators, the measurement and monitoring processes and the subsequent use of the validated data.

Typical EPIs in the first two categories may include:

MPIs relate the management system and address:

- Policy issues and development, eg effectiveness of environmental commitments
- Resource allocation and purchasing
- Human resource issues, eg staff training
- Planning and practices, eg which objectives are being pursued and achieved
- Conformance with regulations and audit programs

OPIs relate to performance of operations, including:

- Inputs, eg energy, materials, utilities and contractor services
- Through-puts, eg design, installation, operation and maintenance of buildings, materials used, process equipment and other facilities
- Outputs, eg process emissions, trade effluent, emissions to air, solid and liquid wastes, noise, vibration, light, dust, litter, odour and radiation.

Examples of performance indicator data might include:

- Raw materials consumed (including hazardous substances and materials)
- Quantities of emissions and discharges that can have a significant impact
- Environmental protection measures
- Number of polluting incidents or breaches of compliances which attracted fines, damages or increased costs of regulatory inspections
- Performance indicators such as waste generated per unit of production or energy consumption.

EPE is used to assess environmental performance and keep track of how well the EMS is functioning, including whether agreed aims and objectives are being met. ISO 14031 is essentially a monitoring tool, helping an organization:

- Identify environmental aspects and related impacts and determine which are significant

- Set criteria for its environmental performance and track progress towards objectives and targets
- Benchmark performance more easily
- Assess the effectiveness and potential of environmental management initiatives and projects
- Identify inter-relationships of different management functions and environmental performance
- Communicate more effectively through the use of tangible data
- Produce information for stakeholders that relates directly to their concerns and requirements
- Focus on root causes and risk analysis and identifying areas for action
- Regularly provide information to support any review process.

Other tools such as environmental reviews and life cycle assessment (LCA) provide additional information for EPE. LCA is a technique for assessing the environmental aspects and potential impacts associated with the life cycle of products and service systems. LCA is explained in detail in the section Life Cycle Assessment

4.5 Non conformance

Non-conformances are defined as a failure to conform, or non-fulfillment of specified requirements. Basically, whenever an organization does not satisfy the requirements of either the standard, relevant third-party requirements or their own procedures then that would be considered a non-conformance. That really depends on the severity of the non-conformance – when it comes to the certification audit, they are generally separated into two categories, minor (sometimes referred to as a part non- conformance) and major.

Identification of a major non-conformance will often result from;

- Absence of procedures
- Failure to meet requirements of the standard i.e. no management reviews conducted or no internal audits performed
- Actions not aligning with procedures i.e. the procedure specifies equipment to be calibrated every 3 months, but records show this is happening just once per year
- Not addressing a minor conformance identified as part of the audit in the time-frame provided
- Having multiple minor non-conformances that relate to the same process
- Major spill or discharge to air, water and waste

Minor non-conformances are defined as any non-conformance that is not major, or non-conformance is unlikely to result in the failure of the EMS.

For example isolated incident i.e. Daily records are required for equipment use, but it is noted that one record was not inputted

As per ISO 19011:2018 the audit finding are evaluated as conformities and Non conformities based on audit findings and the guidelines for auditing management systems

states in section A.18.3 of ISO 19011-2018, where the following items are recommended for a written nonconformity –

- Description of or reference to audit criteria
- Audit evidence
- Declaration of nonconformity and related audit findings if applicable

4.6 Corrective and preventive actions

Nonconformity is non-fulfilment of a requirement. A requirement may be stated in relation to the management system or in terms of environmental performance. Situation may occur where part of the system may not function as intended or environmental performance requirements are not met.

- Corrective Action - Action taken to correct a known non-compliance/non-conformance.
- Preventive Action - Action taken to bring awareness and to prevent a potential non-conformance.

System for corrective and preventive action is described in two stages. This procedure addresses all types of nonconformities including, but not limited to

a) Results of audits.
b) Inputs obtained from measurement & monitoring.
c) Regulatory non-compliances and incidents and accidents
d) Non-conformances with internal objectives and targets
e) Insufficient documentation to evaluate conformance with EMS
f) Non-conformances with respect to existing policies and procedures.

4.6.1 Corrective action

Below mentioned table details the type of nonconformity, source for its identification, and the mitigation action recommended. Criterion for taking corrective action is described in the subsequent paragraphs.

Sl. No.	Type of nonconformity (NC)	Source for the identification and reporting of NC	Mitigation action
1	Documentation inadequacy to achieve policy and objectives, and to fulfil standards requirements	Audit – adequacy audit	Review and revision of identified document
2	Responsibilities not defined for a system activity	Document review – part of audit	Review and revision of identified document
3	Pertinent operational document not available at the point of use	Audit	Ensure its availability
4	Non-compliance with EMS Legal requirement which was not identified	External Communication	Update legal register; establish compliance
5	Legal and other requirements not complied with	Evaluation of compliance	Establish compliance for the reported finding
6	Operational control not effective to achieve planned results	Management review inputs (related to process performance)	Review and ensure established operational controls are adequate; personnel are competent.
7	Objectives and targets not achieved	Management review inputs; Audit	As decided in the MRM **(**Master of Resource Management)

8	Emergency response not effective	Emergency response report	Revise Emergency response procedures; train personnel
9	Internal audits are not effective	External audit	Review by top management and implement the actions proposed
10	Incident occurred is related to an unidentified aspect.	Internal communication	Implement operational controls; update aspect impact.

4.6.2 Preventive action

Elements for which a preventive action can be implemented are similar to those described under corrective action. One or more of the following means can be utilized to identify opportunity for preventive action:

a) Trend analysis of element (of EMS system) wise nonconformities;
b) Trends in "no loss incidents"
c) Periodic inspection / "walk-through"
d) Suggestion from employees
e) Audit recommendations

Root-cause analysis shall be carried out for the identified / reported potential nonconformity. Preventive actions proposed for an identified / reported potential nonconformity shall be reviewed in the management review meetings or by the EMR for techno-commercial viability. The respective functional heads shall implement those that are approved. Records of the results of action taken shall be maintained.

4.7 Compliance audits

As the name implies, these audits are intended to review the site's/company's legal compliance status in an operational context. Compliance audits generally begin with determining the applicable compliance requirements against which the operations will be assessed. This tends to include federal regulations, state regulations, permits and local ordinances/codes. In some cases, it may also include requirements within legal settlements.

Compliance audits may be multimedia or programmatic. Multimedia audits involve identifying and auditing all environmental media (air, water, waste, etc.) that apply to the operation/company. Programmatic audits (which may also be called thematic or media-specific) are limited in scope to pre-identified regulatory areas, such as air.

Audits are also focused on operational aspects of a company/site, rather than the contamination status of the real property. Assessments, studies.

An Environmental Compliance Audit is conducted by an external and independent auditor. This means they have no business, financial, or personal interest in the outcome of the audit. The auditor will assemble all pertinent data prior to and during a site visit (if applicable). They would then analyze the facts, compare them with the criteria for the audit, draw conclusions, and report their findings.

Environmental Compliance Audit can be simplified into three steps:

Pre-Audit: The auditor will determine which environmental laws, policies, and procedures are applicable to the operations of the business, as well as determine the scope and objectives

of the audit. The auditor must establish the criteria against which the audit will be conducted. Common criteria are company policies and procedures on environmental issues, applicable legislation and regulations, and best environmental management practices.

On-site Audit: The auditor will conduct an assessment to determine whether the business is complying with the applicable environmental regulations, policies, and procedures.
The auditor must develop an understanding of the controls that are in place, including formal procedures and practices, record-keeping and monitoring, inspection programs, and physical controls for containing pollution and spills. Through testing, observation, or inquiry, the auditor will attempt to verify whether the controls work as intended. All information gathered is recorded and evaluated. Potential problems noticed on-site are discussed with the management team or contractors.

Post-Audit: Following the on-site work, the next step is to prepare a report. The auditor will compile an Environmental Compliance Audit report which designates the status of the business as full compliance, partial compliance, or non-compliance. The report indicates the laws and policies the company follows and where the company is non-compliant. In the event of non-compliance, the report will provide advisory action to improve overall environmental legal compliance. The company has the option to request recommendations in the form of an action plan or not.

Once an audit program is in place, future environmental compliance audits will refer to past reports to look for repeat non-compliance, as well as to measure what progress has been made in the implementation of prior recommendations.

Benefits of Environmental Compliance Audits

An Environmental Compliance Audit can benefit companies in several ways:

- Ensures safeguarding of the environment
- Verifies compliance with local and national laws
- Indicates critical current or future problems and environmental impacts
- Assesses training programs, providing data for future environmental training
- Enables companies to build good environmental performance and highlight shortcomings
- Identifies areas for saving, such as waste minimization
- Demonstrates the company's environmental protection commitment to employees, the public, other stakeholders, and the authorities

Auditing compliance within a management system as per ISO 19011-2018

The audit team should consider if the auditee has effective processes for:

a) Identifying its statutory and regulatory requirements and other requirements it is committed to;
b) Managing its activities, products and services to achieve compliance with these requirements;
c) Evaluating its compliance status.

In addition to the generic guidance given in this document, when assessing the processes that the auditee has implemented to ensure compliance with relevant requirements, the audit team should Consider if the auditee:

- Has an effective process for identifying changes in compliance requirements and for considering them as part of the management of change
- Has competent individuals to manage its compliance processes
- Maintains and provides appropriate documented information on its compliance status as required by regulators or other interested parties
- Includes compliance requirements in its internal audit programme
- Addresses any instances of non-compliance
- Considers compliance performance in its management reviews

4.8 Waste audits and Waste minimization planning

A waste audit is a physical analysis of waste composition to provide a detailed understanding of problems, identify potential opportunities, and give you a detailed analysis of your waste composition.

Or

A waste audit is a method for analyzing an organization's waste stream. The goal is to discover what types and quantities of waste (paper, plastic, food etc.) you produce within a given timeframe—usually a week. Auditing also measures how much waste is recycled vs. thrown out.

A waste audit will help you clearly identify your waste generation to:

- Establish baseline or benchmark data.
- Characterize and quantify waste streams.
- Verify waste pathways.
- Identify waste diversion opportunities.
- Identify source reduction opportunities.
- Assess effectiveness and determine ways to improve efficiency of your current waste management systems.
- Gain specific information for local government.
- Obtain detailed data on waste generation.

4.8.1 Waste Audit Process:

The Audit

- The data collected from the audit will identify the type of waste produced by the organization and how the organization manages this waste.
- The audit can also make the organization more effective at reducing waste management costs by educating staff about proper waste disposal and making better use of natural resources. When performing a waste audit, the organization should not inform staff about the audit prior to the completion of the audit.
- Informing staff in advance can alter waste disposal habits resulting in an inaccurate and counterproductive audit.

Validating the Data;

- Once the organization receives the data from a waste audit, the organization must validate the data.
- The company must ensure that the data collected during this process is sample representative. Additionally, the data must consider the organization over time.
- If the organization had previous waste audits, the organization should compare the data from the present waste audit to the data previously generated. Once the organization successfully validates the data and makes sure the data is representative of the habits of the organization, the organization can take measures to make changes to waste management procedures.

Implementation;

- Organizations may choose to implement aspects of the waste audit with the help of different environmental agencies such as the Environmental Protection Agency or various state and local agencies. Environmental agencies have many resources that the organization can use to make the implementation process more effective. Each organization has specific waste management needs, but reduction, collection and recycling are common tools used by organizations during the implementation process.

Monitoring and Reviewing

- In many cases, the initial excitement of performing and implementing these audits does not last long.
- A monitoring and review process performed weekly, bi-monthly or monthly by the organization can help to ensure the long-term success of changes to waste management policies. Typically, organizations will create a waste team responsible for this monitoring and review process.
- Additionally, rotating the team members involved in the monitoring and review process will discourage complacency and encourage organization-wide participation in waste management changes

Identify Wastes;

- The objective of this step is to estimate types of wastes and places where they are generated.
- During the review, you should note existing collection and storage practices and any other
- Special considerations that should be taken into account for the waste reduction work plan.
- The different types of waste that your establishment generates are to complete a walk-through while noting the types of waste and recyclables that are generated in each operation or area.

Estimate Waste Quantities

- It is now necessary to estimate how much of each of the three classifications of waste materials identified above that your operation generates during a specific period.

Depending upon how your waste and recyclables are managed and collected, this may be straight forward or a very complex task.

Identify Recycled Content

This step requires you to examine purchasing specifications to identify the recycled content of purchased products, packaging and raw materials.

Recycled content is any material that is derived from a waste and used to manufacture a product. Recycled content can take two forms:

- Recycled content can be derived from "pre-consumer" (or "post-industrial") waste, which is waste that is generated in the production process, e.g., trimmings from a paper manufacturer.
- Recycled content also can be derived from "post-consumer" waste, which is waste that is generated as a result of a final consumer using a product, e.g., old newspapers or corrugated cardboard boxes.

Complete Waste Audit Report;

- Maintain a record of the information reviewed, assumptions made, waste samples examined (including the sample dates) and the material weights and/or volumes calculated.
- Figure Waste Sampling Record, provides a suggested recording format and example. You may find that you need to complete several of these sampling records, one for each operational area, before actually obtaining the final numbers for your waste audit report.

4.8.2 Waste minimization planning;

Reducing environmental impact: Effective waste management enables you to minimize your company's adverse effects on the environment. A proper waste disposal plan ensures safe, sustainable waste disposal practices to prevent waste from contaminating nearby soil and groundwater.

Staying compliant with regulations: A robust waste management program keeps your company in compliance with local and federal laws. When business is busy, your organization may not always have time to stay apprised of regulatory changes and nuances. If you work with a professional waste management company, though, the professionals there can also keep you updated about any applicable changes in the law and ensure your facility's compliance.

Lowering disposal costs: Many businesses wonder whether professional waste management will be too expensive. Proper waste management services, though, can often reduce your disposal costs. Disposing of industrial waste is usually more costly than disposing of standard municipal waste, so finding ways to reuse and recycle your waste instead can curb your expenses significantly.

Reducing your logistical burden: Proper waste management services reduce the logistical strain on your organization and its resources. When you work with a dependable waste disposal company, its professionals strategize about and handle your waste so you can focus more energy on your core business processes.

Ensuring worker health and safety: You want your company to maintain a safe, comfortable working environment for employees. A good waste management plan helps you do that by educating your workers about safe waste handling practices and reducing the likelihood of disposal-related injuries.

Consider Your Waste Hierarchy

As you plan your waste management practices, consider implementing a hierarchy that prioritizes sustainable processes like reusing and recycling over landfill disposal:

Reduce: Start by examining where your facility can reduce its waste generation. You might discover that more material is coming into your facility than is necessary. Brainstorm ways to scale the sourcing back and minimize the amount of waste you produce.

Reuse: Consider what types of waste your facility can repurpose. For instance, if you have a construction business, find ways to reuse leftover materials from a construction site or repurpose salvaged materials from a demolition.

Recycle: Consider what waste you can divert from your disposal stream and break down for recycling. For instance, if you're throwing away old electronics, look into sending them to a specialized facility that can recycle their metals. If you have waste paper, glass, metal or plastic products, check to see if you can recycle those in your area.

Recover: Waste products you can recover for resale often include scraps of metal and leftover construction materials. With a waste-to-energy program, you may also recover energy from combusting waste.

Dispose: Generally, everything that remains after you've exhausted the options above must go to a landfill. With effective waste management practices, you can often minimize the amount of waste that falls into this category and develop strategies for responsible disposal.

4.9 Due Diligence Audit

- Environmental due diligence is a legal and technical investigation conducted to satisfy certain liability protections using state and federal environmental laws or standards. Due diligence can also be used to develop information about environmental conditions used to allocate liability and manage environmental risks.
- The environmental due diligence audit ensures future regulatory compliance and reduces potential issues as well as future energy and waste costs associated with the property. This assessment is limited and is used as an initial screen of the property to understand the potential environmental liabilities better.
- The first step in performing environmental due diligence is typically a Phase I Site Assessment. The Phase I can be conducted in accordance with American Society for

Testing and Materials (ASTM) Standard E1527 (Standard for Environmental Site Assessment) or All Appropriate Inquiry (AAI) (AAI Final Rule – 40 CFR Part 312. AAI). It should be noted that according to AAI, if an investigation is conducted in accordance with ASTM E1527, it then meets the requirements of AAI.

- The Phase I is intended to protect the commercial real estate property buyer and/or lending institution and to satisfy one of the requirements to qualify for landowner liability protections. The Phase I may also be conducted by the seller prior to marketing a property, in order to better understands the environmental liabilities prior to a sale.

4.10 Environmental statement (form V)

Definition: Environmental statement is process of self-Inspection for Improvement in Processes and Reduction in Waste over the last year.

In today's world every industry is optimizing their Sources, equipment's, Processes to face increasing competitions are forced to minimize Environmental pollution. There is need of pressure on Pollution contributing industries to optimize their production by improving production technologies.

The only mandatory process in Environmental Statement is to fill up the Form V and submit it to Pollution Control Board. Form V consists fields where industry needs to put their last year's Numbers with Current Years Numbers to identify where they stand.

Notification for Environmental Statement form V Published on 28 Apr 1992 by Ministry of Environment and Forest. As per act (Water, Air and Hazardous waste) Every Industry should submit environmental Statement for financial year ending (i.e. 31st Mar) to concerned state Pollution Control Board.

Environmental Statement Form V Contents

In the Environmental Statement every industry should to provide Information on Production, Consumption of raw, Water, Pollutants discharged in environment, Solid and Hazardous waste with their Treatment Processes.

Important things to be reported to Pollution control board are:

- If that company is reusing its by-products or waste material which results in Reduction in consumption of Air, Water or energy.
- Production cost
- Additional Investment proposals for environmental Protection i.e. up-gradation, Improvement in Process or New Equipment's to reduce Environmental Pollution.

Environmental Statement Form V Filling Process

There is total Nine Section in Environmental Statement Form V. It consists

Part A: Basic Information About Company Like Name, Address, Industry Category, Production Capacity and Date of Last Environmental Audit Submitted.

Part B: This Part is for Comparison of Water and Raw Material consumption for this financial year to previous year.

Name of Products	Process water consumption per unit of products	
	During the previous financial year	During the current financial year
1. 2. 3. 4. 5. 6.		

ii. Raw material consumption

Name of raw materials*	Name of Products	Consumption of raw material per unit of output	
		During the previous financial year	During the current financial year

Part C: This Part is to measure Pollutants Discharged to Environment through medium Air and Water. How much in excess, an industry is releasing the pollutants into the environment.

Pollutants	Quantity of Pollutants discharged (mass/day)	Concentration of Pollutants discharged (mass/volume)	Percentage of variation from prescribed standards with reasons.
(a) Water			
(b) Air			

Part D: This part to Measure Hazardous Waste from processes and from Pollution control Facilities

Hazardous Wastes	Total Quantity (Kg)	
	During the previous financial year	During the current financial year
1. From Process 2. From Pollution Control Facilities		

Part E: This Part is to measure Solid waste generated by industry. Also details like Quantity recycled, Sold and Disposed

Solid Wastes	Total Quantity (Kg)	
	During the previous financial year	During the current financial year
a. From process		
b. From Pollution Control Facility		
c. Quantity recycled or re-utilised within the unit.		

Part F: Any new practices adopted to reduce Hazardous waste.

Part G: Impacts of pollution control measures on natural resources and with Cost of Production.

Part H: Additional Investment / Process / measures to minimization or prevention of pollution.

Part I: In this part other information / initiatives to improve quality of Environment needs to be given.

4.11 Recommended questions

1. Give the contents of environmental statement form V
2. Explain the major and minor non-conformities that affect the efficiency of environmental management standards in an industry
3. What is waste audit and how do you plan waste audit in an organization
4. Write a shorts note on waste minimization planning in an industry

4.12 Outcomes

- Develop, Implement, maintain and Audit Environmental Management systems for Organizations.
- Appreciate the elements of Corporate Environmental Management systems complying to international environmental management system standards.

4.13 Further Reading

- https://asq.org/quality-resources/iso-19011
- https://app.croneri.co.uk/topics/environmental-performance-evaluation-epe/indepth

Module – 5
Applications

Structure

5.0 Introduction
5.1 Objectives
5.2 Applications of EMS
5.3 Waste Audit and Pollution Prevention
5.4 Hazardous wastes
5.5 Transboundary movements
5.6 Recommended questions
5.7 Outcomes
5.8 Further Reading

5.0 Introduction:

Mitigate adverse impacts on various environmental components, which have been identified during the rapid environmental impact assessment study.

5.1 Objectives

To develop awareness of the need and responsibility to keep the natural system in a condition that it sustains life

5.2 Applications of EMS

- Environmental Management Systems can help to minimize environmental effects of an organization or company.
- They can help to amplify the productive use of assets that the company has.
- They are shown to help to reduce the amount of waste that a company produces.
- EMS's can help to give the public a good picture of the organization that you have and that you want to be.
- They can play a very large role in constructing the consciousness of environmental concern among people within your organization and that utilize what your organization has to offer them.
- Gain a superior understanding of the environmental effects of business exercises.
- Expansion benefits and enhancement of environmental plan execution, through more productive operations.

EMS Application on

- Agribusiness
- Meat Processing
- Chemical Manufacturing
- Iron and Steel
- Metal Casting:
    - Die Casting Sector
    - Foundry Sector

- Construction Industries

5.3 Waste Audit and Pollution Prevention

A waste audit is a method for analyzing an organization's waste stream. The goal is to discover what types and quantities of waste (paper, plastic, food etc.) you produce within a given timeframe usually a week. Auditing also measures how much waste is recycled vs. thrown out.

Integrating pollution prevention into your industrial waste management system is essential for not only preventing land and air contamination but also to alleviate the burdens, liabilities, and organizational risks associated with waste management. Facility managers, state regulators, and members of the general public are often in the dark about effective waste management and are looking to improve their strategies while cutting costs and improving worker safety.

Industrial waste management includes segregation, land application (composting), landfill, and recycling of waste.

What is Pollution Prevention?

Pollution prevention is any practice that reduces, eliminates, or prevents pollution at its source. It is also known as "source reduction," is the ounce-of-prevention approach to waste management. Reducing the amount of pollution produced means less waste to control, treat, or dispose of. Less pollution means less hazards posed to public health and the environment.

Specific Pollution Prevention Approaches

Pollution prevention approaches can be applied to all potential and actual pollution-generating activities, including those found in the energy, agriculture, federal, consumer and industrial sectors. Prevention practices are essential for preserving wetlands, groundwater sources and other critical ecosystems - areas in which we especially want to stop pollution before it begins.

In the energy sector, pollution prevention can reduce environmental damages from extraction, processing, transport and combustion of fuels. Pollution prevention approaches include:

- Increasing efficiency in energy use;
- Use of environmentally benign fuel sources.

In the agricultural sector, pollution prevention approaches include:

- Reducing the use of water and chemical inputs;
- Adoption of less environmentally harmful pesticides or cultivation of crop strains with natural resistance to pests; and
- Protection of sensitive areas.

In the industrial sector, examples of P2 practices include:

- Modifying a production process to produce less waste
- Using non-toxic or less toxic chemicals as cleaners, degreasers and other maintenance chemicals

- Implementing water and energy conservation practices
- Reusing materials such as drums and pallets rather than disposing of them as waste

In homes and schools examples of P2 practices include:

- Using reusable water bottles instead of throw-always
- Automatically turning off lights when not in use
- Repairing leaky faucets and hoses
- Switching to "green" cleaners

5.3.1 Textile Industry

- Textile industry is concerned with design and production of yarn and cloth and their distribution.
- Textile industry comprises large quantity of water and also need various chemicals and dyeing agents for the process.
- Textile industry arise large quantity of waste in terms of water, energy and other chemical substances which will directly or indirectly affects the environment.
- The pollution may be in the form of air, water or noise.

Water pollution

- The consumption of water includes various processes such as sizing, dyeing, and other end product processes.
- The major problem arises chemicals are directly discharged into water bodies.
- This water pollution not only affects human beings and house hold animals but also aquatic animals.

Effects of water pollution

- Depletion of dissolved Oxygen
- Hinders with self purification process of water.
- Clogs the pores of the soil resulting in loss of soil productivity.
- Corrodes and incrassates the sewerage pipes.
- Affects the quality of drinking water in hand pumps making it unfit for human consumption.
- Leads to leakage in drains increasing their maintenance cost.
- Impurities in water affect the textile process in many ways.

Measures to control water pollution

- Effluent treatment methods can be classified into:
- Physical, chemical and biological methods;
- Exclusive treatment by one of these three methods has proved to be insufficient in removing colour and other effluent from textile industry wastewater.
- Combination of various effluent treatment methods can remove more than 85% of unwanted matter.
- Adoption of best practices: Reducing and Recycling Water

- Awareness to go green
- Practice —Air Dyeing Technology: Air Dyeing Technology is a dying process that uses air instead of water to dye garments, allowing companies to create garments with vivid designs and colours, without polluting the water and environment.
- Bleaching: Chlorine bleach is extremely toxic. An alternative method which is oxygen based can be used.
- Functional Finishes: Rather than using harsh chemicals to soften and finish the fabric a finish made of bees wax, Aloe Vera and Vitamin A are a good alternative.
- Sizing: Instead of the use of polyvinyl alcohol (PVA) for sizing use of potato starch or Carboxy methylcellulose

Air pollution

- The major air pollution problem in the textile industry occurs during the finishing stages, where various processes are employed for coating the fabrics.
- Air emissions include dust, oil mists, acid vapours, odours and boiler exhausts.
- Speculation concerning the amounts and types of air pollutants emitted from textile operations has been widespread but, generally, air emission data for textile manufacturing operations are not readily available.

Measures to prevent air pollution:

- In order to prevent the hazards emission from the industry the workers can be advised to use Material Safety Data Sheets.
- Staff members who regularly handle the chemicals can be given adequate training regarding the over usage of particular chemical and their ill effects on health and environment.
- Height of chimneys should not be less than 30m so that all deadly gases are released out of the living organisms.
- Settling chamber should be used
- Filtration method can also be used for filtering the hazardous pollutants in which bed filter, fiber filters and fabric filters are widely used.

5.3.2 Sugar industry

- Installation of sealed flow metre in
  - Bore wells to ascertain usage of fresh water
  - At major areas of cold and hot water consumption
  - For measuring the effluent from prominent areas
- Maintenance of log book for recording the daily water consumption and effluent generation
- Recirculation of water employed in S2 gas coolers, massecuite cooling, and elsewhere with proper cooling 4. Dry cleaning of factory floors using bagasse
- Construction of tank to collect hazardous wash water generated
- Installation of condensate polishing unit (CPU) where high pressure boiler is used
- Use of membrane-based technology to attain brine recovery

- Use of surplus cooled condensate as make-up water
- Maintenance of retention time in various units of effluent treatment plant (ETP)
- Colour coding of pipelines carrying recycled process water and fresh process water
- Development of proper infrastructure for operation and maintenance of ETP
- Development of analytical facility for analysis of various streams of water
- Commissioning of mechanical sludge handling system of adequate capacity
- Ensuring the analysis of effluent discharge parameters notified under Environment (Protection) Rules, 1986 daily basis.

Pollution Control

- There is scope of recycling and reuse of water in sugar mills thereby minimising water consumption and ultimately effluent quantity.
- The recycling and reuse of hot condensate water can reduce the water consumption to as low as. 100-200 litres, as against 1,500-2,000 litres per tonne of cane crushed.
- Proper housekeeping, periodic checking and maintenance of pipe joints, valves and glands further reduces the water consumption and effluent quantity
- The effluents from the sugar industry can be treated added. The preparation of milk of the lime by conventional biological treatment systems. General, anaerobic biological processes (oxidation ponds and biomethanation) several advantages over aerobic processes (aerated lagoons, activated sludge process).
- Anaerobic processes are easier to control and operate, produce a lower quantity of sludge and their costs are lower. Anaerobic processes decompose the organic compounds in an atmosphere free of oxygen and consequently require significantly less energy as compared to aerobic processes.
- Among the air pollution control of treated equipments; wet collectors and multi-cyclones, can reduce particulate matter in boiler emissions by 90% or more.
- These equipments can reduce. The concentration of particulate matter to 450 mg/ Normal cubic metre. Double Sulphitation Process, already adopted by most of the sugar industries, reduces the quantity of lime sludge and press mud to a I great extent.
- The lime sludge is usually dumped in low lying areas, whereas press mud is sold to farmers as it can be used as manure.
- Bagasse is either used as fuel or sold to pulp and paper industry which use them as raw materials. Molasses produced in sugar industry is raw materials for fermentation industries

5.3.3 Pulp and Paper Industry

India is a vast country with an average of 700 pulp and paper mills. It is one of the highest polluting industries in India and is highly water intensive. Relatively large wastewater discharges and accompanied release of high pollution load into the environment is the sequel of high water consumption and pollution generation in the process of pulp and paper manufacture. Steps are been taken to preserve the resources, especially water which is an integral part of the pulp and paper industrial functioning. The need of cleaner production programs has been felt in recent times by the paper industry by way of a resource and waste

minimization concept. In India efforts have been going on for years to improve housekeeping, optimize process parameters, increase recycles and adopts improved technology. This paper aims at highlighting the process used during manufacture, sources and types of waste generated and treatment options available for improving the quality of waste to be discharged.

Sources of Waste Generation

In pulp and paper industry, considerable quantity of water is used in paper making processes. The quantity of water consumption varies according to the quality and kind of paper to be manufactured. In addition considerable amount of solid waste and gaseous emission occurs.

1. Waste Water Generation

- Washing wooden chips in large-scale pulp and paper mills using wool as raw material.
- Washing of bagasse for separation of pith.
- Washing of rice/ wheat before pulping.

Pulping and bleaching

- Washing of chemically cooked pulp.
- Washing of pulp during bleaching.
- Pulp cleaning equipments.

Stock preparation and paper machine

- Cleaning of pulp in cleaning equipment.
- Filtration for wire section of paper machine.
- Paper machine presses.

Chemical recovery

- Foul condensate from evaporator and steam surface condenser.
- Boilers blow down.

Beside above major sources of wastewater generation there are frequent leakages of black liquor from pump glands and its improper handling, which contribute significant color and pollution to the stream.

2. Solid Waste Generation

In pulp and paper industry solid wastes are generated from following operation;

- Raw material handling.
- Rejects from screening and centri-cleaners.
- Primary and secondary sludges from wastewater treatment system.
- Coal or boiler ash from steam and power generation.
- Lime sludges from caustic zing section of chemical recovery plant.

3. Air Pollution

In pulp and paper industry air pollution is caused due to odour emitting reduced sulphur compounds such as hydrogen sulphide, methylmercaptan, dimethly sulphide, and particulate matter SO_2 and NO_x present in the gases emitted by different process units. Gaseous emission from pulp and paper mills can be broadly classified into the following categories:

- Gases from digesters.
- Gases from multiple effect evaporators.
- Gases from recovery.

Effluent Treatment Practices in Pulp and Paper Industry

Several control and treatment technologies have been developed to reduce wastewater discharge from the pulp and paper industry. The two major technology approaches are:

- At source treatment controls measurements aimed at reducing wastewater volume and pollutant load discharged from the mill.
- Wastewater treatment technologies or end of pipe treatment system aimed at reducing discharge of pollutants in the wastewater.

Segregation: Highly concentrated and offensive effluents are segregated from relatively voluminous effluents.

Chemical Recovery: Efficient recovery of chemicals from the spent liquor is an integral part of modern sulphate (kraft) and soda processes.

Good Housing Keeping: Proper installation and operation of equipment, keeping them well cleaned before emptying into drain. Avoiding unnecessary biodegradable material to be dumped into waste stream, reuse of water when possible, reduces considerably the pollution load.

Reclamation and Recycling: About 80-90% reduction in pollution load and 70 % reduction in effluent volume in chipper house can be achieved through effluent reuse. Similarly recirculation in multi-stage bleaching operation reduces pollution loads by 30- 80%. Effective fiber recovery from paper machine can reduce the pollution load by 20- 60% and volume by 60-80%.

Primary Treatment: It includes coagulation & flocculation, floatation and sedimentation. A well designed clarifier is considered most suitable and is expected to settle 90-95 % of the settle able solids and removes 25-30% of BOD. Clarifier should be designed for an overflow rate of 30 cubic meters per square meter per day and a detention time of three hours. Settled sludge is regularly pumped out at about 3% solid consistency. The sludge can be dewatered to spendable consistency by drying on usual drying beds, vacuum bed filters, and solid bowl centrifuges.

Biological Treatment: Depending upon the conditions at site and degree of treatment required for final disposal of effluents, biological treatment methods that can be adopted include; oxidation pond, aeration lagoon, trickling filter with secondary clarifier and activated sludge process.

5.3.4 Electroplating Industry

Pollution Prevention and Control: Plating involves different combinations of a wide variety of processes, and there are many opportunities to improve on traditional practices in the industry. The improvements listed below should be implemented where possible.

1. **Changes in Process**

- Replace cadmium with high-quality, corrosion-resistant zinc plating. Use cyanide-free systems for zinc plating where appropriate. Where cadmium plating is necessary, use bright chloride, high-alkaline baths, or other alternatives. Note, however, that use of some alternatives to cyanides may lead to the release of heavy metals and cause problems in wastewater treatment
- Use trivalent chrome instead of hexavalent chrome; acceptance of the change in finish needs to be promoted.
- Give preference to water-based surface-cleaning agents, where feasible, instead of organic cleaning agents, some of which are considered toxic.
- Regenerate acids and other process ingredients whenever feasible.

2. Reduction in Dragout and Wastage

- Minimize dragout through effective draining of bath solutions from the plated part, by, for example, making drain holes in bucket-type pieces, if necessary.
- Allow dripping time of at least 10 to 20 seconds before rinsing
- Use fog spraying of parts while dripping.
- Maintain the density, viscosity, and temperature of the baths to minimize dragout.
- Place recovery tanks before the rinse tanks (also yielding makeup for the process tanks). The recovery tank provides for static rinsing with high dragout recovery

3. Minimizing Water Consumption in Rinsing Systems

Testing is required to determine the optimum method for any specific process, but proven approaches include:

- Agitation of rinse water or work pieces to increase rinsing efficiency
- Multiple counter current rinses
- Spray rinses (especially for barrel loads)

4. Management of Process Solutions

- Recycle process baths after concentration and filtration. Spent bath solutions should be sent for recovery and regeneration of plating chemicals, not discharged into wastewater treatment units.
- Recycle rinse waters (after filtration).

- Regularly analyze and regenerate process solutions to maximize useful life. • Clean racks between baths to minimize contamination.
- Cover degreasing baths containing chlorinated solvents when not in operation to reduce losses. Spent solvents should be sent to solvent recyclers and the residue from solvent recovery properly managed (e.g., blended with fuel and burned in a combustion unit with proper controls for toxic metals).

5.3.5 Tanning industry

The leather industry is one of the main examples of industries which play an important role in the Indian economy in terms of exports and employment opportunities, while being blamed for environmental pollution

Effects of waste discharged from tannery on environment

- Pollution of environment by tannery waste is one of the most horrible ecological crisis to which we are subjected today. Due to lack of proper management facilities the tannery waste creates environmental pollution day by day.
- About 95% of the tannery industries have been built in unplanned way. These unplanned tanneries caused environmental pollution very much.
- These wastes affect the main elements of environment such as air, water and soil and the animal or plants living depending on these elements are harmed drastically.
- It was showed that the most harmful environmental effect was bad smell to the surrounding areas which caused environmental pollution

Cleaner technology in Leather Processing

Cleaner technology in leather processing can significantly reduce the costs of environmental compliance by reducing effluent loadings and chemical costs in leather manufacture. The pressure to adopt cleaner technologies normally emanates from environmental imperatives such as the need to meet specific discharge norms, reduce treatment costs or comply with occupational safety and health standards.

The typical primary targets are:

- Lower water consumption,
- Improved uptake of chemicals,
- Better quality/re-usability of solid waste, and
- Reduced content of specific pollutants such as heavy metals and electrolytes

Waste Minimisation Measures

Systematic implementation of the waste minimisation measures **in tannery** sector can provide a viable solution to the environmental problems faced by the tanners as well as assist the tanners in improving their profitability. The following measures should be taken:

a) All the tanneries shall install water meters and flow meters to measure actual consumption and waste water discharged. Water consumption rates shall be brought down to less than the prescribed limits per tonne of hides by taking water conservation measures.

b) Process-wise, some of the waste minimisation measures to be adopted by the tannery units include the following:

i) Soaking: The waste minimisation measures for reducing water consumption inter-alia include:

- Use of counter current system of washing to concentrate the salt and other soluble materials such as dirt and blood.
- Reuse of the 2nd main soak for dirt soak: Soaking consists of dirt soak and main soak. The main soak is retained and used for dirt soak for the following batch.
- Reuse of dirt soak: The dirt soak liquor may be collected and added polyelectrolyte to flocculate and settle the suspended solids. Soak liquor thus treated and filtered can be reused partially in liming, deliming washes and pickling.
- Drum soaking instead of pit soaking: This will not only reduce water consumption but will also bring down the soaking time from 12 hrs to 3 hrs. This will enable the tanners to construct solar evaporation pond in less area thereby using the open land for more productive use.
- Addition of soaking enzymes: Soaking enzymes are added to achieve uniform and thorough soaking. Further, to improve the treatability of waste water, regular wetting agent should be substituted with biodegradable wetting agents.
- Stop "open washing systems‖ in drum washing. Use batch systems only. Batch washing involves washing of hides and skins during processing by introducing the required quantity of clean water into the processing vessel and using the action of the vessel to achieve the required agitation as opposed to running water washes which use the inflow and outflow of large quantities of water.

ii) Liming: The following measures shall be adopted to optimise chemical consumption in this process step. These include:

- Substitution of paste lime by 85% pure calcium hydroxide [Ca(OH)!]: This will bring down the quantity of consumption of powdered lime to one third ofits original quantity. lt will also reduce the frequency of cleaning the primary settling tanks which consisted mainly of the lime sludge.
- Use of liming enzymes: Use of liming enzymes will reduce Sodium sulphide (NaS) consumption by 40%. □ Provision of a slight slope in the pasting area: By providing a slight slope in the pasting area the excess liming paste can be effectively collected and used which is otherwise washed away in the drain by lime yard workers.
- Reuse of relime liquor: 50% of relime liquor can be retained and reused for liming of subsequent batches. This will also reduce water consumption in liming. In addition to optimisation of the chemical consumption in liming section, fleshings can be used to produce biogas, gelatine, glue and also high-grade protein. This will solve the problem of solid waste disposal from the liming section.

iii) Deliming: Efforts should be made to reduce the water consumption in this section process by implementing the following measures:

- Use of deliming agents such as ammonium chloride/ ammonium sulphide.
- Use of 2nd delimes wash for liming.
- Reduce the use of ammonium by the injection of carbon dioxide gas

iv) Pickling: In this process, the following measures should be adopted to reduce salt consumption: a. Use of drained float for next batch or go directly to tanning. b. Controlling pickle liquor to 6° - 7° to optimise use of sodium chloride (NaCl).

v) Chrome tanning: The following measures should be adopted to recover chrome from chrome tanning process, if it is applicable for the tannery. It may be restricted by the need to produce leather properties which meat the customer requirement in particular related to dyeing (reduced fastness and less brightness of colours) and fogging. a. Collection of spent chrome liquor after basification and recovery of chrome from the same. The recovered chrome can be used along with regular Basic Chrome Sulphate (BCS) for chrome tanning.

vi) Dyeing: The waste minimization measures under this process include the following: a. Use of soft water for dyeing process to reduce the dye consumption as well as syntans consumption, in case, the fresh

5.4 Hazardous wastes

A solid waste is a hazardous waste if it is specifically listed as a known hazardous waste or meets the characteristics of a hazardous waste.

- The collection, treatment, and disposal of waste material that, when improperly handled, can cause substantial harm to human health and safety or to the environment.
- Hazardous wastes can take the form of solids, liquids, sludges, or contained gases, and they are generated primarily by chemical production, manufacturing, and other industrial activities. They may cause damage during inadequate storage, transportation, treatment, or disposal operations.
- Improper hazardous-waste storage or disposal frequently contaminates surface water and groundwater supplies as harmful water pollution and can also be a source of dangerous land pollution.
- People living in homes built near old and abandoned waste disposal sites may be in a particularly vulnerable position. In an effort to remedy existing problems and to prevent future harm from hazardous wastes, governments closely regulate the practice of hazardous-waste management

5.4.1 Classification of Hazardous wastes

A waste is determined to be a hazardous waste if it is specifically listed on one of four lists (the F, K, P and U lists) according to Code of Federal Regulations (CFR) in part 261.

1. The F-list, found at 40 CFR sections 261.31, identifies wastes from common manufacturing and industrial processes as hazardous.

2. The K-list identifies hazardous wastes from specific sectors of industry and manufacturing and is considered source-specific wastes.
    - Pesticides manufacturing,
    - Petroleum refining,
    - Veterinary pharmaceuticals manufacturing,
3. The P-list identifies acute hazardous wastes from discarded commercial chemical products.
4. The U-list identifies hazardous wastes from discarded commercial chemical products. The U-list wastes can be found at 40 CFR sections 261.33.

5.4.2 Characteristics of Hazardous waste

- Hazardous wastes are classified on the basis of their biological, chemical, and physical properties. These properties generate materials that are either toxic, reactive, ignitable, corrosive, infectious, or radioactive.
- Toxic wastes are poisons, even in very small or trace amounts. They may have acute effects, causing death or violent illness, or they may have chronic effects, slowly causing irreparable harm. Some are carcinogenic, causing cancer after many years of exposure. Others are mutagenic, causing major biological changes in the offspring of exposed humans and wildlife.
- Reactive wastes are chemically unstable and react violently with air or water. They cause explosions or form toxic vapours. Ignitable wastes burn at relatively low temperatures and may cause an immediate fire hazard. Corrosive wastes include strong acidic or alkaline substances. They destroy solid material and living tissue upon contact, by chemical reaction.
- Infectious wastes include used bandages, hypodermic needles, and other materials from hospitals or biological research facilities.
- Radioactive wastes emit ionizing energy that can harm living organisms. Because some radioactive materials can persist in the environment for many thousands of years before fully decaying, there is much concern over the control of these wastes.
- However, the handling and disposal of radioactive material is not a responsibility of local municipal government. Because of the scope and complexity of the problem, the management of radioactive waste particularly nuclear fission waste is usually considered an engineering task separate from other forms of hazardous-waste management

5.4.3 Treatment of Hazardous waste

- Hazardous waste can be treated by chemical, thermal, biological, and physical methods.
- Chemical methods include ion exchange, precipitation, oxidation and reduction, and neutralization.
- Among thermal methods is high-temperature incineration, which not only can detoxify certain organic wastes but also can destroy them.

- Special types of thermal equipment are used for burning waste in either solid, liquid, or sludge form. These include the fluidized-bed incinerator, multiple-hearth furnace, rotary kiln, and liquid-injection incinerator. One problem posed by hazardous-waste incineration is the potential for air pollution.
- Biological treatment of certain organic wastes, such as those from the petroleum industry, is also an option. One method used to treat hazardous waste biologically is called land farming. In this technique the waste is carefully mixed with surface soil on a suitable tract of land.
- Microbes that can metabolize the waste may be added, along with nutrients. In some cases a genetically engineered species of bacteria is used. Food crops are not grown on the same site. Microbes can also be used for stabilizing hazardous wastes on previously contaminated sites; in that case the process is called bioremediation.
- The chemical, thermal, and biological treatment methods outlined above change the molecular form of the waste material.
- Physical treatment, on the other hand, concentrates, solidifies, or reduces the volume of the waste. Physical processes include evaporation, sedimentation, flotation, and filtration. Yet another process is solidification, which is achieved by encapsulating the waste in concrete, asphalt, or plastic.
- Encapsulation produces a solid mass of material that is resistant to leaching. Waste can also be mixed with lime, fly ash, and water to form solid, cement like product

5.4.4 Disposal methods of Hazardous waste

1. Underground disposal

- The only way this method is compliant is when the hazardous waste is brought to mines that are either inactive or partially active (along with meeting additional geological and technical specifications).
- Many companies need to dispose of radioactive waste, whether from medical treatments, laboratory experiments, nuclear fuel production, or radioactive ore mining. For those cases, this method is considered a strong, cost-effective option.
- These hazardous waste facilities will vary in their sustainability, per the EPA. The agency is responsible for protecting people and the natural world by verifying that these units' design, operation, and maintenance adhere to its standards.

2. Landfill disposal

- Dumpsites and landfills are the most commonly used and oldest method of waste disposal. Hazardous waste landfills are specially built and are NOT intended for liquid wastes. They are engineered and excavated so that they are within the ground rather than piling upward.
- These landfills are lined with clay, HDPE, or other non-porous materials to prevent the waste from leaching into the ground. Wind dispersal controls, leak protection systems, and a double liner are additional protections so that humans and the environment come into contact with as little of the waste as possible.

- Human health is generally not impacted by hazardous waste landfills. However, it is possible for people near the landfill to be harmed if there is a leak.

3. Ocean dumping

- For the avoidance of groundwater contamination, deep-sea depositing is sometimes used. It is necessary to treat hazardous waste before ocean dumping to minimize the impact on marine life. This treatment is important to human health, too, since the waste can make its way to humans when they consume seafood. Some environmental agencies ban this practice, but it is allowed by the EPA if you have a permit and strictly follow its guidelines
- Regarding sustainability, treatment is critically important. Radioactive waste, industrial waste, and sludge all cause considerable ocean pollution. Mercury and cadmium, toxic heavy metals, are within about 10 percent of dredged material.

Hazardous Waste Disposal Alternative:

Recycling – A federal analysis revealed that 1.5 tons of hazardous waste was managed through recycling in 2017. Recycling is preferable to disposing of hazardous wastes for numerous reasons. It results in economic benefits, decreases our raw material reliance nationally, conserves natural resources, prevents pollution, and cuts energy use.

Any of the following are ways that recycling can be achieved:

Reclaiming – Regeneration or processing to recover a useful product

Reuse/use – Substituting it for another product or using it as an industrial ingredient

Burning to recover energy – Burning for fuel

Disposal through use – Placement of waste on the land

5.5 Transboundary movements

Transboundary pollution is the pollution that originates in one country but is able to cause damage in another country's environment, by crossing borders through pathways like water or air. Pollution can be transported across hundreds and even thousands of kilometres. The incredible distances that pollution can spread means that it is not contained within the boundaries of any single nation. This is why it is called 'Transboundary Pollution'.

Transboundary pollution is that which can carry pollution away from a heavy emitter and deposit it onto a nation whose emissions are relatively low.

Example for Transboundary pollutants

Wind Transportation of Contaminants: Wind Currents like those shown below bring pollution from the South to the Arctic.

River Transportation of Contaminants: The flow of rivers shown below that end up in the Arctic Ocean also shows how contaminants are carried from places such as Russia, which may still carry large deposits of PCBs and other contaminants.

Ocean Transportation of Contaminants: Other contaminants may travel to the Arctic on Ocean currents. As this illustration shows, many of the major ocean currents flow through the Arctic. These strong winds and currents flowing to the Arctic transport pollution to the Arctic and the cold temperature of this environment acts as a "storage" place for these contaminants.

Transboundary pollution can be caused by **catastrophic events such as the Chernobyl nuclear explosion**. It can also be caused by the creeping of industrial discharge that eventually has a measurable impact on adjacent countries.

5.6 Recommended questions

1. Briefly discuss the applications of EMS and waste audit
2. Explain the concept of Transboundary of pollutants
3. Discuss the pollution prevention opportunities in Textile
4. Discuss the pollution prevention opportunities in Pulp & Paper
5. Write a note on Hazardous classification and characteristics

5.7 Outcomes

1. Lead pollution prevention assessment team and implement waste minimization options.

5.8 Further Reading

1. https://www.unep.org/resources/report/basel-convention-control-transboundary-movements-hazardous-wastes
2. https://www.britannica.com/technology/hazardous-waste-management/Treatment-storage-and-disposal
3. https://corpbiz.io/learning/classification-of-hazardous-waste/