Cleaner Production Manual

Prepared in accordance with CP Guideline

Wool Dyeing Industry

Enhancing the Sustainability and Profitability of the
Carpet and Pashmina Industries in the Kathmandu Valley

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I. Acknowledgement

This Cleaner Production orientation manual for Wool Dyeing Industries is the result of Cleaner production activities being implemented in Wool Dyeing enterprise, an European Union funded project "Enhancing Sustainability and Profitability of the Carpet and Pashmina Industries in the Kathmandu Valley" implemented by Mercy Corps Nepal and partner, SEED Nepal. The objective of this initiative is to establish safe and healthy environment through efficient use of industrial resources, improve environmental performance of the industries and its productivity.

We are thankful to Central Carpet Industry Association and Nepal Wool Dyeing Industry Association for their continued support and cooperation, allowing the project to carry out Cleaner Production interventions in sample industries.

We believe this manual will be a useful tool and serve as a guideline in regards to implementation of cleaner production in each individual small and medium enterprise within the sector. This package is envisaged to foster better understanding of the Cleaner Production steps and process that needs to be followed during the course of implementing Cleaner Production.

We thank the project team members who have been very instrumental in developing the contents for the manual. Additionally, the preparation of the manual was successful with the investment of time and expertise from Devtec Nepal Pvt. Ltd and its partner Soft-Tech C.I Pvt Ltd, a company geared towards providing Management Consultancy on Environmental Management Systems, Quality Occupational Health and Safety, Information Security Management System, Business continuity Management and Cleaner production services.

Special acknowledgement is made to Mr. Surendra Chaudhary, Program Manager of the project who dedicated most of his time peer reviewing, editing the contents and transforming into a manual to conclude to the stage of its publication

The project acknowledges the increasing interest of practicing Cleaner Production in wool dyeing industries and attempts to achieve the integration of environmental, social and economic impacts.

This Cleaner Production manual will be very helpful in many wool dyeing industries to guide them on how to implement Cleaner Production activities. It is also dedicated to all industrial owners, managers, and workers who are the key drivers in implementing Cleaner Production in the industries.

_____

Sanjay Karki

Country Director

II. Summary

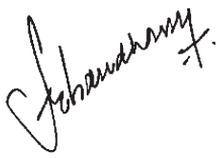
Cleaner production is the continuous application of an integrated preventive environmental strategy to industrial process, products and services so as to increase efficiency and reduce risks to humans and the environment.[1] The objective of cleaner production manual for Wool Dyeing industries is to provide step by step guidance on how to conduct cleaner production assessment and implementation. The manual explains all steps which managers for small, medium and large industries can use to conduct cleaner production assessment and finally implement it.

The central element in cleaner production assessment is the analysis of material and energy flow entering the process in order to identify opportunities for cleaner production and solve problems related to waste and emissions at their source.

The manual provides the essential information and illustrations to conduct cleaner production assessments. It comprises of mainly five phases and several steps for each phase. The first phase is called planning and organization. The objective of this phase is to convince the management and employees in the industry of the need for cleaner production.

The steps for this phase are to get management commitment and involvement cleaner, form a project team, establish cleaner production goals, identify barriers and find solutions. The second phase is called pre-assessment, it involves development of process flow chart which describes the entire process, and it shows all steps through which the raw materials pass to form a product. Other steps are evaluation of inputs and outputs, setting of cleaner production focus and evaluation of occupational health and safety. The third phase is called the assessment phase. The stages involved are to derive the material balance which helps in identification and quantification of unknown emissions and losses, conducting of a cause assessment to show the sources and causes of waste emissions and energy loss, generation and screening of cleaner production options. Feasibility study is the fourth phase. The steps involved are preliminary evaluation, technical evaluation, economic evaluation, environmental evaluation and selection of options for implementation. The fifth phase is called the implementation phase, which includes steps for preparation of cleaner production plan, implementation of cleaner production options, sustain cleaner production activities and evaluation of implemented options.

Sustainability of cleaner production activities within the industry could be possible if the industry shall continuously find ways to improve its environmental performance and that cleaner production shall remain to be the priority for the management and employees of the industry.



Surendra Chaudhary
Program Manager

[1] UNEP's definition of Cleaner Production

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IV. Abbreviations

ADM	:	Administration
AS	:	Audit Schedule
ASL	:	Approved Supplier List
ASR	:	Audit Summary Report
BOD	:	Biological Oxygen Demand
CA	:	Corrective Action
CAL	:	Calibration
CAPA	:	Corrective Action and preventive action
CCP	:	Complaints cum corrective & preventive actions
CNC	:	Control of Non-Conformance
COD	:	Control of Documents
COR	:	Control of Records
CEO/MD	:	Chief Executive Officer (Managing Director)
HOD	:	Head of Department
IDT	:	Identification & traceability
IQA	:	Internal Quality Audit
LED	:	List of external document
MR/FM	:	Management Representatives/Factory Manager
MRM	:	Management Review Meeting
NCR	:	Non-Conforming Report
NCS	:	Non-Conforming Service
OC	:	Organisation Chart
OMC	:	Objective Measurementhart
PA	:	Preventive Action
PR	:	Personal Record
PRO	:	Procedure
PUR	:	Purchase
CPMS	:	Cleaner Production Management System
Ref. Doc.	:	Reference Document
SPR	:	Supplier Performance Rating
SRF	:	Supplier Registration Form
TP	:	Training Plan
TS	:	Training Schedule
TS	:	Training Schedule
WI	:	Work Instructions

1. Introduction:

Cleaner production is the continuous application of an integrated preventive environmental strategy in an industrial process, products and services so as to increase efficiency and reduce risks to humans and the environment. The objective of cleaner production manual for Wool Dyeing industry is to provide step by step guidance on how to conduct cleaner production assessment and implementation. The manual explains all steps that have to be followed to conduct cleaner production assessment and finally implement it.

The organization shall adopt cleaner production (CP) tool for producing quality products and preserve the environment and resources. The internal and external stakeholder will be benefited by adoption of Cleaner Production Management System (CPMS) by the organization. The organization has considered achieving following objectives after implementation of CPMS;

- To minimize the waste
- To minimize the energy
- To improve the working environment
- To reduce wastage and reworking and cost

The continuous application of CPMS within the organization increases the efficiency of products, services and reduces business risks. This approach shall benefit the organization by minimizing waste, enhancing productivity and profitability.

The organization shall consider that the Cleaner Production (CP) doesn't only reduce the environmental Pollutions but also adds value to its products and services providing the organization with economic benefits. CP is a very cost effective approach and easy to implement within any organization, without compromising the quality during the product formulation process.

This is a generic CP Orientation Manual which shall serve as a guideline in the wool Dyeing Industry for enhancing the productivity through applying effective measures to reduce waste/ pollution, energy consumption and improve occupational health and safety conditions.

2. Controlled Copy Holders

Original Copy is maintained with Management Representative.

List of copyholders

S. N.	Designation	Controlled No.
	MD/CEO	Master Copy
	Manager/Factory Manager/Management Representative	Controlled copy no 1

MR controls the distribution of this manual.

- The CP Intervention is Prepared by Management Representative (MR) and approved by MD.
- Any changes observed are recorded in the revision history sheet (given in the beginning of this manual) and MR ensures distribution of amendments to all concerned.
- MR is responsible for ensuring that the hard copy of the CP Intervention manual is readily accessible and maintained.

3. Scope

This manual specifies requirements for a CP Management System where organization

- Needs to demonstrate its ability to consistently provide product and services that meets customer requirement and applicable statutory/ regulatory requirements, and
- Aims to enhance customer satisfaction through the effective application of the system, including processes for continual improvement of the system

3.1 Determining the scope of the CP Management System

The organization has determined its boundaries and the applicability of the CP Management System to develop its scope.

3.2 CP Management System

The organization has established, implemented, maintained and committed to continually improve a Cleaner Production Management System (CPMS) including the processes needed and their interactions in accordance with CP guidelines.

The organization shall maintain documented information so as to evaluate whether the operation process is carried out as planned or not.

4. Leadership

4.1 Leadership and commitment

Top management of the organization shall demonstrate their leadership & commitment with respect to CP management system by:

- taking responsibility for the effective implementation of the CP management system;
- ensuring that the CP policy and CP objectives are established for the CP management system;
- ensuring the integration of the CP management system requirements into the organization business processes;
- ensuring that the organization resources needed for the CP management system are provided;
- communicating the importance of effective CP management system;
- ensuring that the CP management system achieves its intended results;
- Engaging, directing, & supporting employees to contribute to the effectiveness of CP management system.
- promoting improvement;
- Supporting other relevant management tasks which fall within their areas of responsibility.

4.2 Focus

Top management of organization shall be committed towards ensuring and maintaining client/customer satisfaction. Client/Customer feedback process shall be developed and improvements will be made based on the feedback.

4.3 Policy

4.3.1 Developing the CP Policy

Top management of organization shall establish and implement an appropriate Cleaner Production (CP) Policy and ensure that the policy includes commitment to satisfy applicable governmental requirements.

Illustration: CP Policy

We are committed to establish, implement and maintain CP System utilizing CP tools within the organization in order to meet and exceed the customers' satisfaction. We are committed to fulfill the statutory and regulatory requirements.

4.3.2 Communicating the CP Policy

CP Policy shall be communicated to all employees.

4.4 Organizational roles, responsibilities and authorities

The top management of organization shall develop an organization chart and provide with Job descriptions to the employees communicating of their relevant roles, responsibilities and authorities.

5. Planning and Organization

Objective: To convince the management and employee of the importance and the necessity to switch towards Cleaner Production.

Top management of the organization shall formulate objectives with an aim to improving their environmental performance. Appropriate planning shall be done with the active participation of the employees to achieve the objective.

The planning and organization of CP can be eased by preparing and reviewing the checklist.

S.N		Yes	No	Not Relevant
1.	Is the management aware about cleaner production concept including their roles?			
2.	Are all the employees aware about implementation of CP within the organization and do they have knowledge regarding CP?			
3.	Is cleaner production policy being issued?			
4.	Are the goals of CP set?			
5.	Are all the resources (human and financial) needed for implementation of CP being provided or allocated?			
6.	Are the barriers to cleaner production identified and measures to overcome them planned?			

The CP team shall be required to possess sufficient knowledge regarding the process of the organization so that feasible and viable cleaner production options can be identified. Following are the questions for which the CP team shall be aware before implementation of CP.

1. Does the industry comply with environmental regulations?
2. Has the industry invested in environmental measures?
3. What are the processes that produce wastes and what quantity of waste and emissions are produced by those processes?
4. Are the types and quantity of waste and emissions generated by the industry recorded?
5. Is log book maintained?
6. Are the records on the amount of raw materials used per process available so as to monitor process efficiency?
7. Are there any procedures for disposal or reuse of the wastes?
8. Is the Material Safety Data Sheets (MSDSs) of the materials used and maintained in the industry?
9. Is the storage area designed to minimize earthquake damage, control spills and other mishaps?
10. Has the company incorporated promotion of cleaner production in their marketing strategies?

5.1 Getting Management Commitment and Involvement

Step 1:

Objective: To gain support for the cleaner production assessment from top management.

Top management of the organization shall be committed for the effective assessment and implementation of Cleaner Production (CP) within the organization. The owners and management team shall be aware of the potentials of Cleaner production practice in generating value addition for their product and services after implementation of cleaner production. Additionally, the organization can influence the stakeholders by sharing the intangible, social and economic benefits that can be achieved through proper implementation of CP.

The top management shall gather commitment from employees to conduct cleaner production assessment. The employees shall be made clear of the process. Management views shall be gathered during decision making process for key activities inclusive of budget allocation, performing tests and trials and other resources. The employees shall be encouraged to share the progress details with the top management periodically.

5.2 Formation of a Cleaner Production team

Step 2:

Objective: The Cleaner Production team to oversee the Cleaner Production assessment and intervention.

Top management shall form a CP team in order to establish, implement and continually improve CP Management System. The number of persons in the team shall depend upon the size and type of organization. The team members shall understand all aspects of the industry and its production process. The members shall be selected based upon their knowledge, creativity and capability to work as a team.

Illustration: CP Team

S.N.	Team Members	Designation	CP Team
1.	Ram Hari Sharma	Factory Manager	CP Team Leader
2.	Sita Sharma	Washing Master	Member
3.	Hari Sharma	Washing Master	Member
4.	Krishna Sharma	Cutting Master	Member
5.	Shiva Sharma	Raw Material Store Keeper	Member
6.	Bishnu Sharma	Quality Controller	Member

Top management shall include employees from different departments including production, utilities, maintenance, quality and store to form a CP team within the organization. Depending upon the needs, management shall choose to include external consultants or experts to be a part of the CP team who shall provide new ideas and make appropriate and rightful decisions.

After formation of CP team the members shall be provided with roles and responsibilities. The team leader shall be appointed from within the CP team members to lead the team. The team leader shall be provided with the responsibility in addition with the authority to execute the activities effectively. Top management shall or may consider forming a subcommittee and or independent member/team to oversee the effectiveness of CP implementation within the organization.

Responsibilities of team members

- The management team is responsible for setting and enforcing long term goals.
- The technical team or an engineer shall carry out technical feasibility of proposals and identify parameters for process optimization.

- The members from environmental background shall ensure compliance of environmental regulation.
- The finance team shall carry out financial analysis of costing, expenditure and income of current operation and saving and income after implementation of CP.
- The sales and marketing team shall understand Cleaner production process to better communicate to their clients.
- The production team shall provide accurate description of production practices and suggest ideas on new approaches and support the team.

Tasks of CP Team

The key tasks include:-

- Analysis and review of best practices.
- Development and evaluation of changes.
- Implementation and maintenance of system.
- Documentation of activities, management of waste material recording system and monitor the result.
- Ensuring the continuity of cleaner production activities.

5.3 Establishing Cleaner Production (CP) goal

Step 3:

Objective: Cleaner Production goals shall be established

The organization shall establish a goal that will function as guidelines for cleaner production assessment. The set goal shall be Specific, Measurable, Achievable, Realistic and Time bound i.e. (SMART). The cleaner production goals shall base on historical production data, internal productivity, standards and environmental legislation. The goal shall be focused on improving the productivity and product quality, reduction of waste, optimization of raw material, minimizing the energy consumption and improvement of housekeeping and occupational, health and safety condition within the organization. The goals shall be refined as the project team gains insight of cleaner production.

Criteria for setting cleaner production goal

- Cost for labor, maintenance and inputs.
- Waste generation.
- Disposal method and cost.
- Chemical reactivity.
- Air emissions.
- Health effects.
- Known substitutes / alternatives.
- Flammability.

Illustration: CP Goal

1. Reduction in fiber damage during storage, by % compared to last year.
2. Decreasing waste generation during washing process by __ % compared to last year.
3. Reduction in consumption of dyes and chemicals by __ % compared to last year.
4. Improving housekeeping and working conditions by conducting cleaning activity at least twice a day.
5. Reduction in amount of waste water by __ %, compared to last year.

5.4 Barriers and Solutions

Step 4:

Objective: Identify solutions to barriers

The organization is likely to face various barriers. Some barriers may lead to indifferences or even

create conflict within an organization which may slow down the process and affect the progress, therefore, it is necessary to identify possible barriers beforehand and measures to overcome the barriers.

5.4.1 Attitudinal Barriers

The organization consists of employees from different walks of life with different values, culture knowledge and religion. Some of the employees will be hesitant or will show reluctance in changing their behavior which normally is known as attitudinal barrier. The resistance to change is due to working styles, practices, lack of professionalism and negligence of workers etc. To overcome this barrier the organization shall conduct CP awareness raising sessions, CP training, counseling and motivational programs for the employees which shall influence the employees in a positive way. The organization shall introduce incentive schemes to motivate its employees.

5.4.2 Inadequate Information

The communication gap between the employees and the top management may slow down the process to effectively implement CP. Top management shall thus, motivate each employee enabling them to effectively communicate to avoid gap in flow of information. A communication matrix shall be developed in order to maintain flow of correct information.

5.4.3 Organizational Barriers

Lack of cooperation and coordination between individuals working inside and outside the industry, lack of financial resources and failure in allocating human resources are some of the hindrances in implementation of CP.

5.4.4 Economic Barriers

The top management is interested in making profit and not loss, so more emphasis is on production and not waste minimization. Availability of finances, cost of human natural resources and economic policies affecting the industry may hinder implementation of cleaner production. Investment on time, money, human resources has to be made to start cleaner production assessment, but the management may not want to invest in cleaner production. So, it is advisable to start with cleaner production options which do not need investment.

5.4.5 Technical Barriers

The technical barriers are referred to as lack of technical know- how to implement CP. Limited in plant expertise, lack of access to external technical support and lack of technical training at workshop floor act as barrier in implementation of CP. The organization shall focus availing techno-management personnel to mitigate such barriers. Although technology is not a big factor that shall seriously limit adoption of cleaner production but sometimes technical expertise do impede the changeover to cleaner production practices. Hence, the organization shall focus on availing techno-management personnel to mitigate such barriers.

5.4.6 Systemic Barriers

Poor record keeping and reporting, inadequate and ineffective management systems are big systemic barriers. Also, lack of public pressure and absence of monitoring mechanism from the authorized bodies for controlling pollution may make the industry not see the importance of adoption of cleaner production. The organization shall foresee the significant environmental costs that may occur in the long term provided CP is ignored.

5.5 Preparation of Flow Chart

Step 5:

Objective: Identification of steps for the CP implementation and assessment forming the basis of material and energy balance.

The process flow chart is prepared by connecting individual unit operations or processes in the form of a block diagram. The chart shall list all the inputs including utilities, outputs, wastes, waste treatment and disposal taking care of recycle stream where available. This will help to identify major waste generating segment within the process.

A woollen yarn dyeing process flow diagram is presented below under illustration 4 and 4.1.

Illustration: Process Flow Diagram for Wool Dyeing Process

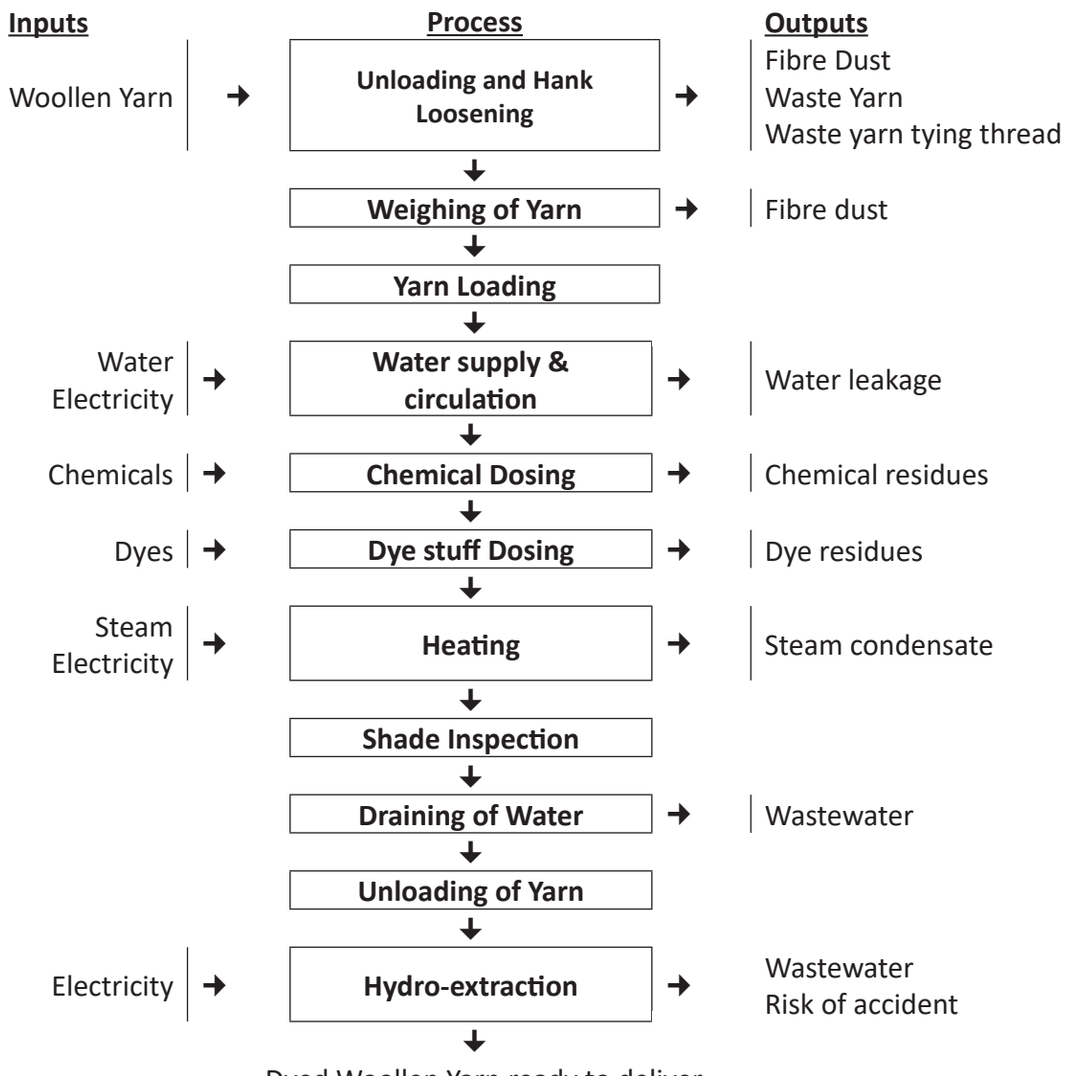
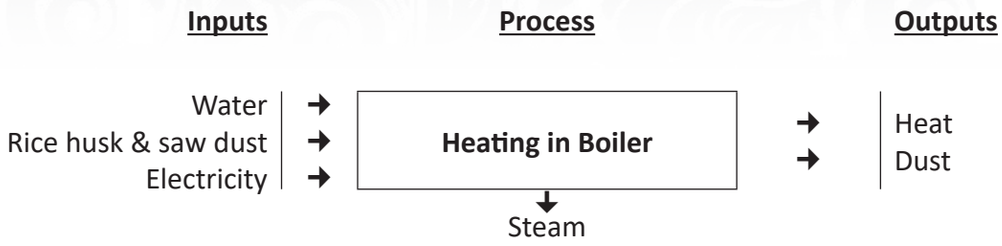


Illustration: Process Flow Diagram for Wool Dyeing Steam Generation process



5.6 Analysis of Inputs and Outputs

Step 6:

Objective: To determine qualities of the inputs results in reasonable quantity of outputs.

The organization shall have a rough analysis of inputs and outputs of the processing. The efficiency of any process can be determined by calculating how much inputs are converted into products and how much into waste. The data of the quantities of inputs and outputs shall be recorded periodically so that before and after comparison can be made.

Illustration: Input-Output table of Wool Dyeing process

INPUT		OUTPUT (PRODUCT & WASTE)	
ITEM	**QUANTITY (KG.)**	**ITEM**	**QUANTITY (KG.)**
Water			
Woolen Yarn			
Chemical			
Total			

5.7 Selection of Audit Focus Area

Step 7:

Objective: To set the focus for cleaner production assessment based on the results of input and outputs

The setting of the focus for the cleaner production assessment is basically a refinement of the cleaner production goals which have been defined during the planning and organization phase. The information which is collected during the pre – assessment phase shall be documented as prerequisite for the next level assessment, which is crucial for analyzing the 'before- and- after' scenario and comparison of prior and post implementation of CP practices and options

The focus of cleaner production assessment shall be in areas which;

- Generate significant quantity of waste and emissions.
- Causes high economic loss.
- Has numerous obvious cleaner production options

5.8 Assessment Phase (Material Balance)

Step 8:

Objective: Calculation of material balance through input-process-output flow

The organization shall focus on the material balance calculation through the input-process-output in

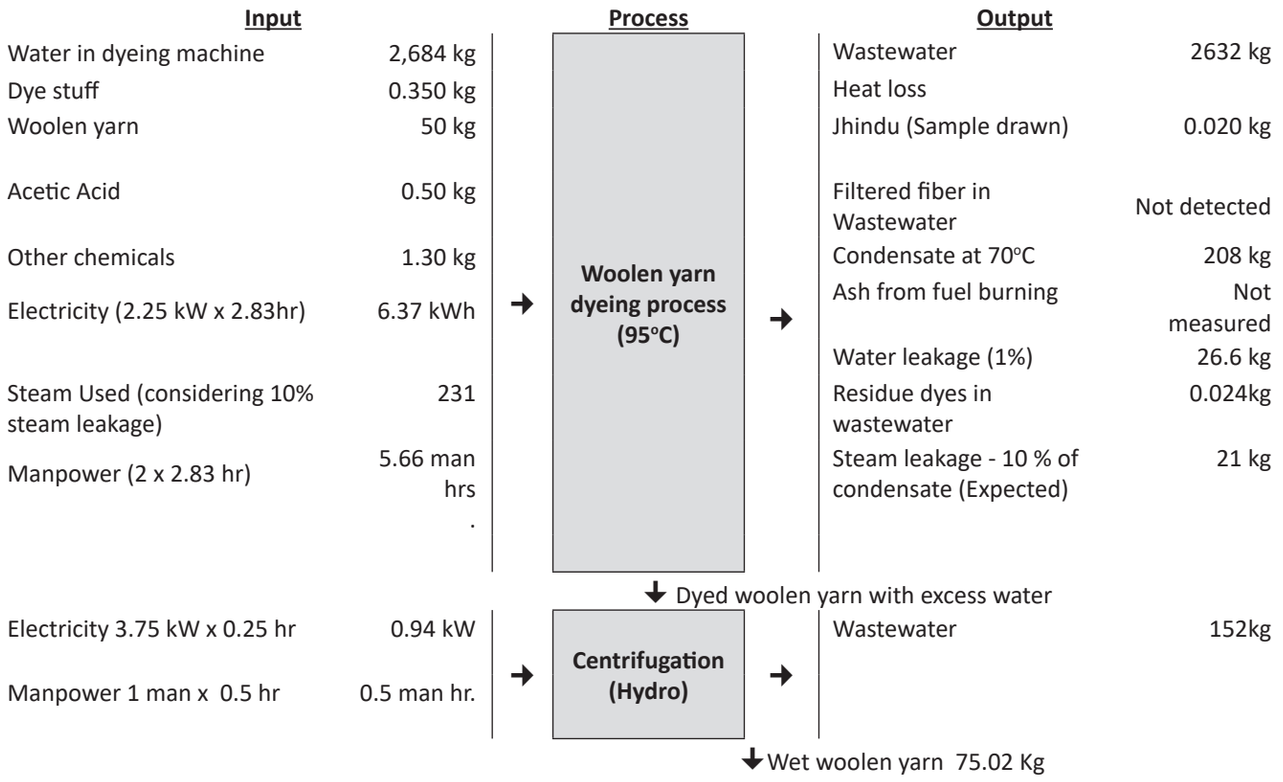
the cleaner production assessment. Any type and size of the organization needs to have required energy to process the input (material) which ultimately generates the output along with the waste. Based on the principle of material balance i.e. ***What goes in the process must come out,*** one can assume that, for any input item, quantity of input must be equal to the quantity of the output.

The process flow chart forms the basis for calculation of material balance. The material balance helps to identify the amount and hence the value of waste and emissions. This, in turn, will be helpful in setting the goals for its reduction.

The units of measurement of inputs and outputs could vary from case to case. However, the following guidance may be considered during the material balance process:

- Consider the amount of inputs and outputs for the whole batch.
- Take at least two full batches in the case of batch production. It is important to include the start-up and the dyeing operations.
- If losses are associated with shutdown or in the start-up, averaging over long periods may be necessary.

Illustration: Standard Operating Procedure for Material Balance of Wool Dyeing Process



The major sources of information for material balance are the historical records and the results of experimental determinations. The following sources of information can be considered to deriving material balance.

- Purchase records
- Material inventories
- Batch composition or recipe records
- Product information from suppliers

- Product specification
- Analysis or test reports of input and output materials
- Production records
- Energy bills
- Fuel Bills and Electricity Bills
- Literatures on the production technology
- Consultants' and experts' opinion
- Interview with operators and other shop-floor employees

Input Analysis

During the material balance, the following breakdown of inputs shall be made:

- Raw materials and auxiliaries
- Water
- Energy

Generally the following questions shall be answered for;

Inputs:

- What are the inputs?
- What is their function in the production process?
- What are the costs of these inputs?
- What is the quantity of consumption?
- Are there any hazardous materials being used? If yes, what is the quantity?

Output Analysis

The outputs are generally broken down into the following categories:

- Products
- By-products
- Waste and emissions
- Energy loss

The following questions shall be considered to conclude outputs

- What are the products and by-products?
- What is the quantity of different products produced?
- What are the wastes and emissions generated?
- What are their compositions and quantities?
- What types of energy losses are there? And what are the quantities?
- What are the costs of product loss, energy loss, waste and emission?
- What hazardous materials are there in the waste?

The information available in the figure above are derived below in the table with the quantities of items as inputs and outputs.

Illustration: Standard Operating Procedure for Input-output flow

Input		Output (Product & Waste)	
Item	**Quantity** (Kg.)	**Item**	**Quantity** (Kg.)
Water		Dyed wet woolen yarn	
Dye stuff		Drained wastewater	
Woolen yarn		Dyestuff in wastewater (6.7 %)	
Acetic Acid		Woolen yarn *Jhindu* loss (sample and other)	
Other chemicals		Woolen fiber in wastewater	
		Water from Hydro extraction	
Steam used		Water leakage (1% Expected)	
		Condensate	
		Expected steam leakage	
		Unaccounted	
Total			

5.9 Cost of Waste Calculation

Step 9:

Objective: Determine the actual annual monetary loss incurred in the industry due to generation of waste in a particular process (audit focus areas).

This attracts the management and the concerned personnel to pay due attention in the areas in order to minimize loss. In Wool Dyeing Industry, the main wastes generated are chemicals and waste water with chemicals. The process associates with loss is generally calculated on an annual basis.

Illustration: Standard Operating Procedure for Total Cost of Waste relating to focus area

S. N.	Waste Item	Annual consumption according to the record (a)	Annual Requirement			Additional consumption (due to spillage, leakage, mishandling, weighing error, etc.) in kg e= a-(b+c+d)	Average price of the dyestuff (NPR/kg) (f)	Cost of waste/loss due to (in NPR)		
			according to Material Balance (b)	For re-dyeing (c)	For Other process (d)			Re-dyeing g=(c) x (f)	Spillage, leakages, weighing error and other causes h = (e) x (f)	Total i =g+h
1	Dyestuff (kg)									
2	Chemicals (kg)									
3	Water (m^3)									
4	Fuel (rice husk) in MT									
5	Fuel (Diesel in liter)									
6	Electricity (kWh)									
7	Yarn and Fiber									
TOTAL COST										

(Washing process required for 25% of the ……. =……. kg, chemical required 10 Kg/50 Kg yarn = ……..)

Water used for Boiler including blow down etc.

Washing process required for 25% = ……. kg yarn =….. m^3

Water used for personnel purposes $2m^3$x283 days = $566m^3$

@ 20% of total electricity consumption for common place

Step 10:

Objective: Identification of Sources causing waste generation

The organization shall have insight to material balance and knowhow of waste and emissions being generated and loss of energy .For every unit, under audit focus area, the material balance shall be prepared and the causes of waste generations shall be identified The organization shall delegate CP team the authority to start the assessment process with the involvement of larger group to identify the causes of wastes.. The following checklist tool can be considered to identify the causes of waste generation

A. Technical Causes

a. Poor Housekeeping

- Leaking taps/valves/flanges
- Spillage
- Overflow
- Worn out materials

b. Operational and Maintenance Negligence

- Unchecked water/air consumption
- Unnecessary running of equipment
- Sub-optimal loading
- Lack of preventive maintenance
- Sub-optimal maintenance of process condition

c. Poor Raw Material Quality

- Use of substandard / cheap raw material
- Lack of quality specification
- Shortage of supply
- Improper purchase management system
- Improper storage

d. Poor Process/Equipment Design

- Mismatched capacity of equipment
- Wrong material selection
- Poor design
- Adoption of avoidable process steps
- Lack of information/ design capability
- Impractical product design

e. Poor Layout

- Unplanned/adhoc expansion
- Poor space utilization plan

- Bad material movement plan

f. Poor Technology

- Continuation of same technology despite/raw materials change
- High cost of better technology
- Lack of availability of trained manpower
- Small plant size
- Lack of information

B. Managerial Causes

a. Inadequately Trained Personnel

- Increased dependence of casual/contract labor
- Lack of formal training system
- Lack of training facilities
- Job insecurity
- Fear of losing trade secrets
- Lack of availability of trained manpower
- Over work-pressure due to understaffing

b. Employee De-motivation

- Lack of recognition
- Absence of reward/punishment system
- Emphasis only on production, not on people
- Lack of commitment and attention by top management

Illustration: Standard Operating procedure for Cause of Waste and mitigation

Technical Causes		
Poor Housekeeping	**Operational and Maintenance Negligence**	**Poor Raw Material Quality**
• Leaking taps/valves/flanges • Spillage • Overflow • Worn out materials	• Unchecked water/air consumption • Unnecessary running of equipment • Sub-optimal loading • Lack of preventive maintenance • Sub-optimal maintenance of process condition	Use of substandard / cheap raw material Lack of quality specification Shortage of supply Improper purchase management system Improper storage
• Unplanned/adhoc expansion • Poor space utilization plan • Bad material movement plan	• Continuation of same technology despite/raw materials change • High cost of better technology • Lack of availability of trained manpower • Small plant size • Lack of information	Mismatched capacity of equipment Wrong material selection Poor design Adoption of avoidable process steps Lack of information/ design capability Impractical product design

Managerial Causes	
Inadequately Trained Personnel	**Employee De-motivation**
• Increased dependence of casual/contract labor • Lack of training and workshop • Job insecurity • Fear of losing trade secrets • Lack of availability of trained manpower • Over work-pressure due to understaffing	• Lack of recognition • Absence of reward/punishment system • Emphasis only on production, not on people • Lack of commitment and attention by top management

5.10 Cleaner Production Option Generation

Step 11:

Objective: Identification of solutions through cause analysis

The organization shall make sure that the CP options are generated on the basis of causes of wastes and emissions. The organization shall seek straightforward solution for the causes identified. The organization can seek the help of *Consultants, Equipment suppliers, Research institutions, Trade Associations to gain further insights to have a clear picture on possibilities of identifying potential practical options that can be generated and adopted to improve its operational process.*

Furthermore, good housekeeping and process control, substitution of input materials, onsite recycle and reuse, equipment modification and technology change, product and by-product reformulation options may be considered while following the process of option generation.

Brainstorming sessions are found to be very helpful tool in generating options for cleaner production. Following points shall be considered while conducting a brainstorming session:

- There shall be no hierarchical constraints preventing anyone from sharing the ideas.
- Sessions shall be planned in a setting that people can think creatively.

Illustration: Cause Analysis and Options Generation during Brainstorming Session

Source	Waste Stream	Cause of Waste	Options	Anticipated Benefit
Storage and Losing the thread of hank	Dyestuffs and chemicals	Expired chemicals due to excess stock lack of knowhow on use of first in first out system	Discourage holding excess stock of chemicals and dyestuffs.	Saving of chemicals and dyestuffs
		Less use of specific weighing balances resulting in excess consumption of chemicals and dyestuffs. Lack of record keeping and monitoring system	Motivate chemist, dyeing master and assistants to use appropriate weighing balance for weighing dyestuffs, appropriate measuring scale/jars. Maintain record book for chemicals & dyestuff and monitor accordingly	
		Use of ordinary balance to weigh chemicals and dyestuffs	Introduce digital weighing balance of 500 gm with three digit capacity to weigh dye stuffs and chemical.	
	Woolen yarn	Storing of woolen yarn on the moist floor Damage by insects and rodent (mouse)	Store woolen yarn on dry surface (wooden plank) in the store room. Use anti insect and mouse repellant	Saving of yarn and dyeing cost Saving of time and
		Tight bundling of the hank received from different parties Use of woolen thread for bundling the hank	Suggest/request yarn supplier and spinning parties to supply loose bundling hank	
Yarn loading into Boiler	Wastewater, chemicals, Fuel and pollution to environment	Short hank compare to machine height No uniformity in length of the hank	Suggest to yarn suppliers/ parties to provide uniform length and size of the hank Maintain hank loading to machine according to the quantity of hank	• Savings in fuel usage • Reduction in exhaust gas and less pollution,
		Negligence of boiler operator	Instruct and motivate boiler operator to pay attention during boiler operation	
		Cold feed water to dyeing cabinet	Install solar water heater for pre-heating the feed-water to dyeing machine	
		Lack of proper kit to measure regulation for Air Fuel ratio, Emission level high.	Use fyrite kit set to regulate Air Fuel ratio to boiler	
		Negligence of operator	Train boiler operator to maintain and regulate Air Fuel ratio during the firing of the boiler. Install bag filter before emitting and discharge.	
		No insulation on condensate collecting pipe line	Insulate condensate collecting pipe line	Reduction in occupational hazard
		Unutilized heat from drained wastewater	Utilize heat from drained waste water for feed water heating	Savings in fuel

Source	Waste Stream	Cause of Waste	Options	Anticipated Benefit
Dyeing process	Chemicals and wastewater	Heat loss from the wall of the dyeing machine	Insulate the wall of the dyeing machine	Productivity enhancement
		Feeding cold water in the boiler and dying machine	Heat feeding water by using waste heat from hot wastewater	Productivity enhancement
		Shade not matching with the sample Patching in color in dyed woolen yarn, No perfect color fastness, Wastewater does not meet discharge standard.	Raise awareness and motivate dye master and assistants for proper color matching and good operating practice Use pH meter, heating time and thermometer for process control. Introduce carrier dying machine for dyeing woolen yarn Improvement in wastewater treatment plant	Reduction in re-dyeing process, saving of chemicals/ dyestuffs, saving fuel usage And prevention of environmental protection and pollution control through proper wastewater management.
		Manual dye/chemical solution preparation and not maintain uniformity.	Use electric stirrer for making dye / chemical solution preparation to maintain uniformity.	Uniformity maintained
		Moist dyestuff and chemicals due to open containers.	Practice use of closing the containers before and after use	Savings in chemical resource
		Inconsistencies in samples provided by customers	Establish and maintain communication with customers and dyeing masters to maintain consistencies and conformities.	Decreased product non-conformities
		Inconsistencies in quality of dyestuff the supplied	Ensure quality of dyestuff by referencing with supplier and catalogue for each supply batch. Train dyeing master to cross and check balance to maintain consistencies and quality of supplies.	Enhanced product quality
	Chemicals, dyestuffs and Water	Slow heating of the water solution in the cabinet	Complete insulation of the boiler and pipelines, Control steam leakage and increase steam pressure.	Heating efficiency enhanced.
		Power supply irregular and low voltage Motor trip	Installation of voltage stabilizer Installation of transformer	Continuous power supply
		No proper maintenance of the dyeing machine and leakage of the dyeing cabinet.	Introduction maintenance checkup system and regular maintenance of dyeing machine/cabinets.	Long operational life of machinery.
		Dyeing in bigger vessel that require excess water, dyes and chemicals	Introduce work plan, establish standard of water required for dyeing and operation of appropriate size of machine according to the quantity of the yarn to be dyed.	Process efficiency enhanced and saving in chemical usage and dyestuffs
		Discharge of wastewater	Practice of reuse of waste water to the possible extent. Use alternative chemicals with less pollution (Invatex instead of acetic acid.	Reduced environmental impact

Source	Waste Stream	Cause of Waste	Options	Anticipated Benefit
		Over flow from overhead tanks	Introduction fixed level limit and automated overflow cut off system.	Saving in water and reduction of effluent
		Non-existence of reuse of the waste water for darker shade	Reuse of lighter shade waste water for darker shade as far as possible	Less water consumption
		Spillage of chemicals and dyestuffs solution during dosing into machine. Accidental risk while climbing to top of dyeing machine for pouring the solution.	Use of pump and containers to feed and dosing into machine. Use of safe ladder for pouring the solution into machine.	Less use of chemicals & dyestuffs, Enhanced occupational health safety
Dyeing unit	Electricity	Using tube light in day time	Fix translucent fiber glass sheet to utilize day light and or LED lights.	Saving in electricity consumption
		Motors in operation without cooling fan	Fix cooling fan to the motors	Enhanced process efficiency

5.11 Screening of Options

Step 12:

After possible options have been generated and listed, they shall be screened. The options, which seem obviously impractical and non-feasible, shall be eliminated. The following key approaches shall be considered while screening of options.

- Segregate options by unit operation
- Evaluate obvious mutual interference
- Implement obviously feasible options
- Eliminate obviously non-feasible options

The general recommended options for wool dyeing may be classified into three categories such as No Cost, low cost, cost demanding and OHS & Environmental related options after the screening process.

Illustration: Preliminary Screening of CP Options

S.N.	CP Options	Directly Implementable (No cost low cost)	Requiring Further Analysis (Cost demanding)	Rejected	Remarks
1.	Motivate chemist, dyeing master and assistants to use appropriate weighing balance for weighing dyestuffs, appropriate measuring scale/jars.	√			
2.	Introduce digital weighing balance of 500 gm with three digit capacity to weigh dye stuffs and chemical.	√			
3.	Motivate dyeing master and his team members to close the dyestuff containers after use.	√			
4.	Store woolen yarn on dry surface (wooden plank) in the store room.	√			

S.N.	CP Options	Directly Implementable (No cost low cost)	Requiring Further Analysis (Cost demanding)	Rejected	Remarks
5.	Introduce trolley system to transport wool and yarn.	√			
6.	Make suggestions to yarn suppliers/ parties to provide uniform length and size of the hank.	√			
7.	Instruct and motivate boiler operator to pay attention during boiler operation	√			
8.	Install and use pH meter, time clock and thermometer for process control		√		
9.	Substitute acetic acid with Invatex		√		
10.	Introduce carrier dyeing machine for woolen yarn			√	
11.	Use electric stirrer for preparation of dye and chemical solution		√		
12.	Keep the containers of the chemicals and dyestuff in closed condition and use of auto closing type containers (if available)	√			
13.	Establish proper communication with customers & to ensure supply of uniform material (yarn/wool)	√			
14.	Refer and consult the catalog of the dyestuff suppliers and check the quality of the dyestuff	√			
15.	Practice of using treated water required for dyeing		√		
16.	Fix level limit switch and or installation of automated overflow water cut off system in overhead tank.	√			
17.	Reuse of lighter shade wastewater for darker shade as far as possible		√		
18.	Improvement of wastewater treatment plant		√		
19.	Use of pump and solution container for feeding the chemicals and dyestuff into machine instead of manual bucket pouring.		√		
20.	Train the boiler operators for proper regulation of fuel air ratio during the firing of the boiler	√			
21.	Complete insulation of the boiler and steam pipe lines		√		
22.	Collect the condensate in insulated tank for use in yarn washing		√		
23.	Install solar water heater for pre heating the feed water to dyeing cabinet.		√		
24.	Utilize heat form drained wastewater for feed water heating		√		
25.	Insulation of the wall of dyeing machine		√		
26.	Use of energy efficient motors			√	
27.	Use of energy efficient lighting, bulbs	√			General

S.N.	CP Options	Directly Implementable (No cost low cost)	Requiring Further Analysis (Cost demanding)	Rejected	Remarks
28.	Introduce preventive maintenance system for control of steam leakage and machine break down		√		
29.	Uninstall Steam Release Valve and reduce the steam pressure			√	
30.	Introduction of production and or workplan	√			
31.	Use of efficient generator			√	
32.	Use of UPS			√	
33.	Installation of transformer 50 KVA			√	
34.	Installation of voltage stabilizer 50 KVA		√		
35.	Fix cooling fan motors	√			General
36.	Renovate/redesign flooring so that waste water is collected in one pit to avoid draining and spillage spreading over the working floor	√			OHS
37.	Use of platform type ladder for drawing samples and pouring chemicals and dyestuffs		√		
38.	Install bag filter before emitting the smoke to environment.	√			Environment
39.	Cover the motor driving belts in the dying machines	√			OHS
40.	Install cover to Hydro extractor with auto cut system.	√			OHS
41.	Installation of ABC type fire extinguisher, first Aid box and eye washing facilities.	√			OHS
42.	Orient employees on emergency preparedness	√			OHS
43.	Indicative linings (mark red lining in and around dyeing cabinet, hydro extractor, boiler and yellow lining in and around raw and finished goods store and passes).	√			OHS
44.	Keep and follow the MSDS for dyes and chemicals	√			OHS
45.	Replacement of mechanical balance with digital balance for weighing of chemicals in the laboratory	√			OHS
46.	Introduce practice of placing corks/covers on all chemical containers/ bottles/ conical flasks in chemical store and laboratory.	√			OHS
47.	Ensure use of PPE by workers	√			OHS
48.	Installation of push pulls ventilation in dyeing unit	√			OHS
49.	Use of micropipette or pipette pipes for drawing of liquid chemicals in the laboratory	√			OHS

Post- Assessment Phase of the Cleaner Production

Feasibility Analysis

Preliminary Evaluation

Step 13:

The selected options shall be evaluated for their technical, economical and environmental feasibility. However, for some options, comprehensive evaluation may not be necessary. The preliminary evaluation of options will determine the purpose of carrying out further level of technical, environmental and economic evaluations.

Procedural versus technical options:

Some options may only require changes of procedures and reshuffling of employees as per the need. However, other options may require further technical change.

- **Relatively simple versus complex options:**

  Simple options such as minor technical changes and good housekeeping practices may be introduced which can be implemented without or with little investments, whereas complex options may require replacement of a unit operation, requiring further technical and economical evaluation

- **Low cost/expensive options:**

  Options can be selected judging upon their implementation costs.

5.13 Technical Evaluation

Step 14:

The organization shall carryout technical evaluation and determine whether proposed CP options are technically feasible. The impact of the implementation of the option on process, product, productivity, safety etc. shall be considered. In addition, laboratory testing or trial runs of the options may be required when the option is significantly changing the present process practice.

The organization shall consider following factors for the technical evaluation

- Effect on product quality
- Effect on production capacity
- Availability of manpower
- Repair and maintenance requirement
- Additional both technical and managerial training requirement
- Availability of space, storage, transportation etc.
- Safety aspects

The checklist shall be used to carry out technical evaluation based on the above points.

Illustration: Check list for Cleaner Production Option:

S.No.	Options	Yes	No	Remarks
1.	Will this option maintain product quality?			
2.	Will this option affect production?			
3.	Will this option require additional staff?			

5.14 Financial Evaluation

Step 15:

The organization shall carry out the economic evaluation to calculate the economic benefits from the implementation of the options. Potential benefit that may accumulate in the short or long term from the savings and increase in the profit due to enhancement in the productivity shall be considered as focus area while carrying out financial evaluation. Cost benefit analysis and payback period of such investment shall be calculated to determine its return on investments.

Illustration 13: Standard Operating procedure for Financial Evaluation

A. Fixed investment cost

- Construction and development cost
- Equipment cost, etc.

B. Additional operating cost

- Interest
- Depreciation
- Maintenance cost
- Manpower cost, etc.

C. Total Savings

- Savings due to reduction in raw materials, chemical, water consumption
- Energy savings
- Savings due to reduced pollution load etc.
- Additional profit revenue generated due to higher production, better quality or better price tag due to goodwill.

D. Net Saving

The net saving = Total savings – additional operating cost

Payback period= (Investment/Net saving) X 12 months

(Period of time (years) needed to generate enough cash flow to recover the initial investment)

If the payback period is less than or up to three years, it may be considered an attractive period for return on investment. Most of the options will have payback period less than one year. According to the payback period, the options can be ranked as low, medium and high.

5.15 Environmental Evaluation

Step 16:

The organization shall carry out environmental evaluation to know the net reduction in the pollution load. The organization shall consider calculating different factors to make a sound environmental evaluation of which some of them are listed below

- Change in the amount and toxicity of waste and emissions
- Change in the energy consumption
- Change in the pollution load (COD, BOD, TSS)

The organization shall prepare a checklist to identify the impact of options on the environmental aspects. The options can thus be ranked low, medium and high.

Illustration: Check list for Environmental Evaluation of the CP Option:

S. N.	Environmental Impact	Yes	No	Remarks
1.	Does this option reduce the toxicity and volume of solid waste?			
2.	Does this option reduce the toxicity and volume of liquid waste?			
3.	Does this option reduce the toxicity and volume of gas emission?			
4.	Does this option reduce the energy consumption?			
5.	Does this option reduce the pollution load (DO, COD, BOD, TSS etc.)?			

5.16 Selection of Options

Step 17:

The organization shall consider the feasibility analysis of each screened option in terms of expected savings, investment/expenses required for implementing the options and most importantly its payback period. Non-feasible options shall be dropped from the list. Only technically, financially and environmentally feasible CP options shall be considered for implementation.

Illustration: No Cost Low Cost Options reference

S.N.	CP Options	Expected Saving	Expenses or investment required NPR	Remarks/ Pay Back Period
1.	Motivate dyeing master and team and his assistants for keeping the lid of the dye stuff containers closed after use and use appropriate handling of chemicals and dyestuffs.			
2.	Introduce digital balance of 500 gm with three digit capacity for dye stuffs and measuring scales/pot for chemicals weighing and keep the record of used chemicals & dyestuff and monitor accordingly			
3.	Hank Loading to the appropriate machine according to the quantity of hank to be dyed			
4.	Substitute acetic acid with new chemicals named Invatex (trade name)			
5.	Use electric stirrer to prepare dye /chemical solution			
6.	Keep the containers of the chemicals and dyestuff in closed condition and use auto closing type containers if available			
7.	Establish proper communication with customers & to ensure supply of uniform material (yarn/wool)			
8.	Ensure quality of dyestuff by referencing with supplier and catalogue for each supply batch. Train dyeing master to cross and check balance to maintain consistencies and quality of supplies.			
9.	Fix level limit switch or install automated overflow cutoff system in overhead water storage tank			
10.	Train boiler operator to maintain and regulate Air Fuel ratio during the firing of the boiler			
11.	Introduce production work plan			

Illustration: Cost demanding Options reference

S.No	CP Option	Investment	Annual Saving	Payback Period
1.	Reuse of lighter shade and rinse wastewater for darker shade as far as possible			
2.	Improvement of waste water treatment plant			
3.	Use of pump and solution container for feeding the chemicals and dyestuff into machine instead of manually feeding.			
4.	Install and Use pH meter, time clock and thermometer for process control			
5.	Collect the condensate in insulated tank and reuse for yarn washing			
6.	Utilize heat from drained wastewater for feed water heating			
7.	Install solar water heater for pre heating the feed water for dyeing cabinet			
8.	Insulate the wall of the dyeing machine			
9.	Use of energy efficient lighting, bulbs			
10.	Installation of voltage stabilizer 50 kVA			

Illustration: OHS and Pollution Control Related Options

S. N.	CP Option	Investment	Annual Saving	Remarks / payback period
1.	Use of conveyor belt for transporting rice husk from store to feeding hopper of the boiler			
2.	Install bag filter before emitting smoke into the environment			
3.	Cover the motor driving belts in the dying machines			
4.	Install cover to Hydro extractor with auto cut system at open position.			
5.	Install fire extinguishers, First Aid box, eye washer etc			
6.	Orient employees on emergency preparedness			
7.	Renovate/redesign flooring so that waste water is collected in one pit to avoid draining and spillage spreading over the working floor.			
8.	Indicative linings (mark red lining in and around dyeing cabinet, hydro extractor, boiler and yellow lining in and around raw and finished goods store and passes).			
9.	follow the MSDS for dyes and chemicals			

Illustration: Criteria for the Selection of CP Option - How to define the weight of each criteria?

S. N.	Criteria	Weight	Option 1 Heat Recovery from Effluent		Option 2 ……..	
			Score	Weight X Score	Score	Weight X Score
1.	Reduction in Waste					
2.	Reduction in toxicity					
3.	Product quality					
4.	Ease of implementation					
5.	Future liability					
6.	Health and safety					
7.	Cost					
8.	Worker acceptance					
	Total					

5.17 Preparation of CP Action Plan

Step 18:

The organization shall prepare a Work plan to allocate the time period necessary for the implementation of the selected CP options and assign the responsible employees. The management shall review the plan periodically to review its implementation and progress.

Illustration: Action Plan for the implementation of CP Options

S.N.	CP Options	Implementation started date	Duration	Responsibility	Remarks

5.18 Implementation of CP Options

Step 19:

The organization shall consider five phase of method as the stages of CP which includes,

- Planning
- Designing
- Procurement
- Construction and Installation
- Commissioning

5.19 Monitoring and Evaluation

Step 20:

An organization shall monitor the performance of the implemented options by evaluating following changes,

- Changes or reduction in wastes and emissions
- Changes or reduction in resource consumption
- Changes or increase in savings or profitability
- Improvement in working conditions

The organization shall carry out CP comparison through a worksheet.

Illustration: Comparison of Before and After CP Option Implementation

S. N.	Aspect	Price/Unit (Rs.)	Before CP	After CP	Change or Saving	Benefit (NRs.)
	Materials					
	Energy					
	Utilities					
	Pollution Load					
	Noise	-				
	Dust	-				

5.20 Sustaining Cleaner Production Activities

Step 21:

Small scale industries are likely to face challenges in sustaining Cleaner Production. The CP shall not be taken as a one-time activity rather as continuous process for improvement. The goal and objective of an organization shall be for continual improvement called the PDCA cycle (Plan-Do-Check-Act). The organization shall adopt the PDCA cycle for the continual improvement of CP.

6. Management Review

Top management shall review the organization CP management system, 2 times or more depending upon the need, to ensure its suitability, adequacy and effectiveness. This review shall include assessing opportunities for improvement and the changes needed for establishing CP management system, including the CP policy and CP objectives or goal within the organization.

6.1.1 Management Review input

Management review meetings shall be planned & carried out considering the following

- Status of actions from previous management reviews;
- Changes in external & internal issues those are relevant to the CP management system.
- Information on the performance & effectiveness of the CP management system

6.1.2 Management Review output

The output from the management review shall include any decisions and actions related to

- Improvement of the effectiveness of the CP management system and its processes,
- Improvement of service related to customer requirements, and
- Further resource needs.

7. Improvement

The organization shall determine and select opportunities for improvement and implement necessary actions to meet the requirements of the customer and provide satisfaction to the customer.

7.1 Nonconformity and corrective action

- The organization shall be committed to react to the nonconformity inclusive of issues arising or feedback form. The organization shall evaluate the need for action to eliminate the cause(s) of the nonconformity, in order that it does not reoccur.
- The organization has prepared formats to note down the nonconformities and corrective actions taken.

7.2 Continual improvement

The organization shall be committed to continually improve the effectiveness of the cleaner production management system through the use of the CP policy, CP objectives, audit results, analysis of data, corrective and preventive actions.

8. Revision history sheet/ amendment sheet

S.N.	Section No./Page No.	Effective Date	Description of Changes	Signatures

Note: The above sheet is an amendment record sheet which shall be updated as a when amendments to the orientation manual is made. Pages and or content will be replaced by new amendments in the manual and recorded in the revision history sheet or amendment sheet. The amendment sheet will serve as a snap shot of amendments made in the orientation manual.