IN DEPTH CLEANER PRODUCTION ASSESSMENT REPORT

Prepared for

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Reviewed & Submitted by

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Bangladesh Water PaCT:

Partnership for Cleaner Textile

About PaCT

PaCT is a partnership between textile wet processing factories in Bangladesh, international apparel buyers, wet processing technology suppliers, the Embassy of the Kingdom of the Netherlands (Dhaka), the International Finance Corporation (IFC), and the NGO Solidaridad.

The PaCT partners share a commitment to bring about systemic, positive environmental change for the Bangladesh textile wet processing sector, its workers, and surrounding communities, and to contribute to the sector's long-term competitiveness.

To this end, the PaCT partners are collaborating to develop harmonized resource-efficiency procurement requirements, to build factory capacity, technical knowledge, and access to finance for Cleaner Production investments, and to create a platform for community and national dialogue on sustainable use of water in the textile sector.

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The consultants are grateful to IFC-Bangladesh for vesting its confidence in the team for carrying out this prominent assignment for the identification of cleaner production interventions in Tusuka Trousers Limited (TTL) and for their full fledged coordination and support throughout the study.

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Table of Contents

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

A	Ampere
APCD	Air Pollution Control Device
BDT	Bangladesh Takka
BGMEA	Bangladesh Garments Manufacturing & Exporters Association
BOD	Biological Oxygen Demand
CFM	Cubic feet per minute
COD	Chemical Oxygen Demand
CP	Cleaner Production
CPA	Cleaner Production Assessment
CW	Cooling Water
DESL	Development Environergy Services Limited
ECR	Environment Conservation Rules

EGB	Exhaust Gas Boiler
ERI	Engineering Resource International (Bangladesh)
ETP	Effluent treatment plant
FTL	Fluorescent tube light
GCV	Gross calorific value
GHG	Green House Gases
H&M	Hennes & Mauritz
HP	Horse Power
Hz	Hertz
IFC	International Finance Corporation
kg	Kilograms
KPI	Key Performance Indicator
kVA	Kilo Volt Amperes
kWh	Kilo Watt Hours
m^3	Cubic Meters
PaCT	Partnership for Cleaner Textile
PF	Power Factor
PHE	Plate Heat Exchanger
ppm	Parts Per Million
PLC	Programmable Logic Control
RCB	Reed Consulting Bangladesh
RFT	Right First Time
RPM	Revolutions per minute
SOP	Standard Operating Procedure
TDS	Total Dissolved Solids
TPH	Tons Per Hour
TSS	Total Suspended Solids
TTL	Tusuka Trousers Limited
UF	Ultra Filtration
V	Voltage
VFD	Variable Frequency Drive
WHRB	Waste Heat Recovery Boiler
WTA	Walk Through Audit
WTP	Water treatment plant

UNITS OF MEASUREMENTS

Parameters	UOM
Calorific value	kcal
Days	d
Hours	h
Kilogram	kg

Liters	l
Meter	m
Million tonnes of oil equivalent	Mtoe
Year(s)	Y
GHG Emission	tCO_2 e

CONVERSION FACTORS

Parameters	UOM	Value
Emission factor natural gas	kg of CO_2/kg of natural gas	1.88
Emission factor electricity	kg of CO_2/kWh	0.656

BASELINE PARAMETERS

Parameters	UOM	Value
Electricity rate (Grid)	BDT/kWh	7.32
Diesel rate	BDT/liter	68.0
NG fuel rate		
For Power generation	BDT/m^3	4.18
For process heating	BDT/m^3	5.25
GCV of NG fuel	kcal/Nm^3	9186
Operating days	days/annum	330
Average operating hours	Hours	24
Annual production	Million pieces/kg	12.75/10201295
Specific energy consumption		
Water	Liters/kg	153.0
Power	kWh/kg	0.56
Steam	Kg/kg	5.78

Executive Summary

Background

The International Finance Corporation (IFC) is implementing the Bangladesh Water PaCT (Partnership for Cleaner Textile) program to reduce environmental and related social impacts that result from prevailing practices in textile wet processing. The project includes 3 components viz. buyer capacity building, supporting factories to set up and achieve cleaner production (CP) objectives and engage multiple stakeholders in support of cleaner textile. The component 2, i.e. supporting factories to set up and achieve CP objectives is envisaged to be delivered in 3 steps, viz.

- Step 1: Build factory awareness of/motivation for CP;
- Step 2: Provide factory-level advice on Cleaner Production (CP) measures, water footprint reduction, leading to adoption of low-cost/no-cost measures (target: 200 factories); and
- Step 3: Provide factory-level advice on in-depth Cleaner Production, leading to investment in technologies with significant water sustainability benefits.

IFC has led the successful implementation of the first two steps, and in-depth assessment in 19 factories. In order to expand the project to a larger scale DESL (Development Environergy Services Limited) has been engaged for in depth cleaner production assessment study in 41 Washing, Dyeing and Finishing units of textile sector in Bangladesh. In the first phase of the assignment, covering 16 factories, DESL is working with the local consultant team led by Reed Consulting Bangladesh Ltd. (RCB) and their associate Engineering Resources International (ERI).

Tusuka Trousers Ltd. (TTL) involved in the washing and garments manufacturing for Denim products. Unit has installed state of the art machineries for washing applications. Table 1 below summarizes the baseline energy consumption, energy consumption post implementation and also the reduction for each of the resources.

Table 1: Summary of savings

Parameters	UOM	Baseline	To be	Reduction	% Reduction
Quantity of Electrical energy	kWh/annum	5709616	4701628	1007988	17.65
Quantity of Natural Gas avoided	m^3/annum	8248017	7245766	1002251	12.15
Quantity of water use avoided	m^3/annum	1560920	1362516	198404	12.71
Waste water discharge avoided	m^3/annum	1355310	1156906	198404	14.64
Quantity of waste avoided	tons/annum				
GHG emissions avoided	**tCO_2/annum**	**15375**	**12830**	**2545**	**16.56**
Chemical Reduction	tons/annum	1532	1379	153	10.00
Chemical Cost Reduction	Million BDT	119	108	12	10.00
Investment Required	Million BDT	31.6			
Financial savings estimated	**Million BDT**	**21.7**			
Energy Bill (Annual)	**Million BDT**	**86.8**			**24.95**

Details of cleaner production measures identified

Table 2: Savings summary

CP No	Cleaner production Actions	Impact of CP Action						Investment Cost Million BDT	Monetary Savings	Simple Payback	Annual Emission Reduction
		Water Use Reduction m^3/annum	Waste Water Discharge Reduction m^3/annum	Chemical Use Reduction tons/annum	Dye Use Reduction tons/annum	Electricity kWh/annum	NG Fuel Saving Nm^3/annum		Million BDT /annum	Months	tCO_2/ annum
Wet Process											
1	Lab to Bulk RFT process performance improvement - RFT percentage to improve from 50 % to 80 %	156080	156080	153.2		285636	489730	20.0	16	15	1108
2	Use of waterless direct softener injection washing for reducing water consumption	10780	10780					4.0			
3	Retrofit of PLC based monitoring and control system on Belly washers	26554	26554					2.2			

CP No	Cleaner production Actions	Impact of CP Action						Investment Cost Million BDT	Monetary Savings	Simple Payback	Annual Emission Reduction
		Water Use Reduction m^3/annum	Waste Water Discharge Reduction m^3/annum	Chemical Use Reduction tons/annum	Dye Use Reduction tons/annum	Electricity kWh/annum	NG Fuel Saving Nm^3/annum		Million BDT /annum	Months	tCO_2/ annum
Combined for ETP1 & ETP2											
4	Bar screen							0.15	Saving in ETP chemical cost- @ 10.7 Million BDT for reduced effluent flow	12 months	
5	Equalization tank							0.50			
6	Physico- chemical treatment							0.60			
7	Sludge Management							0.15			
Utility area											
8	Energy Efficient Lighting System					152112		1.31	0.62	25	99.8
9	Compressed Air – Demand side controller					142560		0.50	0.58	10	93.5

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10	Compressed Air – Leakage Reduction					427680		Negligible	1.74	Immediate	280.6
11	Boiler – Auto Blow down control	4990					115236	0.50	0.63	10	216.6
12	Heat recovery from jacket water of gas engine						396410	1.70	2.08	8	745.3
13	Feed water tank insulation						875	0.004	0.005	10	1.6
	Total	198404	204194	153.2		1007988	1002251	31.6	21.7	18	2545

1. Background

International Finance Corporation (IFC) is implementing the Bangladesh Water PaCT (partnership for cleaner textile program to reduce environmental and related social impacts that result from prevailing practices in textile wet processing. The Program includes a component to support factories setting up and achieving cleaner production (CP) objectives. This component is implemented in 3 steps, viz. building factory awareness, providing factory level advise on adoption of low cost/no-cost measures and providing in depth CP assessments, leading to investment in technologies with significant water sustainability benefits. The program will focus on water as the primary driver for change, but will also address energy and chemical use (water-energy chemical nexus) for an integrated approach to resource efficiency.

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Development Environergy Services Ltd. New Delhi and Reed Consulting Bangladesh have been engaged by IFC to provide in-depth assessments to identified textile units.

1.1 Objective

The specific objectives of this assignment are for identified factories, are to

1. Assess current usage of water, energy , chemicals, GHG emission and waste water discharge in factory

2. Identify saving opportunities by assessing wet dyeing process i.e. Washing, Dyeing and Finishing operations in textile units for delivering water and energy in a more efficient/less wasteful manner

3. Identify various options and investment plan to reduce water, energy , chemical consumption and effluent generation in the textile processing with improvement in ETP and WTP

4. Improve efficiency in resource utilization to make cleaner production at factory level and making the factory owners and decision makers aware of advantages of investing in technologies that significantly reduce consumption of resources like energy, water and chemical use as well as reduce water effluent making the production process cleaner.

5. Identify opportunities for improving energy and water management system

6. On an ongoing system, share with IFC insights and lessons learned from the assessments, and prepare a formal note on lessons learned midway and at the end of the assignment

1.2 Scope of work

The objective shall be achieved through

1. Baseline data collection
2. Detailed technical assessment
3. Advice and demonstration of good practices in the dye house, ETP and utilities in selected 41 textile wet processing factories
4. Follow-up visits to factories for monitoring
5. Dissemination of results and awareness raising

1.3 Methodology

In order to assess the cleaner production opportunity to improve energy efficiency and water consumption of its current operations in WDF textile factories by conducting a walk through audit (site work) along with local consultant's team:

- Walk through audit was planned to understand the process, practices and ground condition of the plants. The consultant's team has identified the opportunities for potential savings by observation and interrogation of plants personnel in Electricity and thermal energy usage, process equipments condition, following process flow up to final product. Use of energy, water and chemical also critically studied to guide local team for necessary supplementary measurements. ETP and water treatment was studied to understand and identify the needs to improve the process and reduce consumption where possible.
- Data collection - Measure, monitor and collect all energy (electrical and thermal) and resource consumption data of the textile wet processing units including water, chemical usage, Effluent treatment plants' operation and chemical used for ETP
    - To help local consultant team to create a resource map of energy and water sources and users in the textile processing facility from the collected data analysis and make an energy/water balance
    - Historical data collection of resource consumption required for baseline establishment
    - The local consultant's team has collected detail information of different parameters such as energy consumption, fuel consumption, water consumption, steam consumption, performance of the boiler, compressed air consumption, thermal energy user areas and

  - other relevant data points to make the complete resource map (energy, water, chemical and effluent)
  - The local consultants team also collected the data for chemicals used in different processes and effluent discharge quantity, quality and effluent treatment process used in present condition
- Suggested measures to reduce end-use demand for energy, chemical and water, for example by improving process system, improving equipment or system
- Suggested measures to improve the efficiency of utility service; for example by steam distribution system improvements, reduction of heat loss, water consumption reduction potential, use of high-efficiency luminaries/motors etc
- Identified measures to enhance heat recovery or heat generation efficiency, processes, also identify measures improvement of ETP functionality, design, up gradation etc
- These reviews included all production operations and supporting utility systems such as boilers, Thermic fluid heaters, Diesel Generator sets, waste heat recovery systems, Insulation systems, dryer system operation, Fans and blowers, Pumps, compressed air systems, lighting systems and Effluent treatment plants etc.
- For each saving opportunity identified above,
  - Estimated the annual saving (energy (kWh), water saving; chemical saving; avoided water discharge, GHG emission (TCO2e), cost (BD Taka & USD) for the measure
  - Estimated the project cost or cost of implementation
  - Calculated the simple payback period.

1.4 In depth cleaner production assessment in Tusuka Trousers Limited

Tusuka Trousers Limited (which will be referred to herein after as TTL) is participating in the current project as a partner unit. It was established in the year 2006. It is an export oriented woven denim garments factory with washing section on its ground floor. This report describes the result of in depth Cleaner Production Assessment (CPA) of TTL. The goal of cleaner production is to avoid pollution by utmost utilization of resources and raw materials. This means that a higher percentage of the raw materials are turned into valuable products instead of being wasted. The chronology of activities is as follows:

- Basic CP assessment was carried out at TTL on November 15 and 21, 2013.
- TTL then participates in level 2 of CP assessment i.e. CP assessment.
- An In Depth form filling workshop including all the batch 5 factories was carried out on 21 October 2014 in H&M office
- RCB (Reed Consulting, Bangladesh) along with the brand sent deep dive questionnaire prepared by IFC in consultation with all stakeholders in December’2014.
- Walk through audit (WTA) was conducted by DESL (Development Environergy Services Limited) in co-ordination with RCB on 30/03/2015 to verify resources available, utilization, resources for process, water and chemical consumption in process, water and waste water utilization and recoveries.
- DESL asked for further data which was provided by RCB.

- DESL will de-brief the unit post WTA on unit specific observations, CP opportunities, measurement & monitoring needs etc.

2. Unit & Process details

2.1 Introduction

TTL is situated at Konabari, Neelnagar and Gazipur, Bangladesh and is the member of Bangladesh Garments Manufacturer and Exporter Association (BGMEA). Details of the unit are tabulated hereunder.

Table 3: Industry details

Parameters	Details
Name of the industry	Tusuka Trousers Ltd.
Address	Konabari, Neelnagar , Gazipur, Dhaka.
Production capacity	NA
Products	Garments/Jeans
Number of workers	8400
Number of working days in a year	340

The production facility comprises the different type of machines and equipment. A list of plant machines and equipment is given **Annexure1**.

2.2 Raw material and finished products

Raw material for TTL is woven finished fabric of different varieties as per style and color of customer requirements and order preferences. Both denim and twill fabrics are being simultaneously processed. Denim garments washing forms about 90% of the total production whereas the other 10% contribution is of twill garments. The average per piece weight of garment (twill and denim) is taken as 800 g. The category wise finished garments production is given below

Table 4: Average Monthly Production

Product Type	Average Monthly Production
Denim Jeans (Pcs)	1062635
Weight (kg)*	850108

* One piece of garment is estimated to be weighing about 800 grams

2.3 Manufacturing process description – Dyeing, Washing and finishing

2.3.1 Garments Washing Process

Bulk production at TTL washing plant is carried out using atmospheric front loading washing machines. A total of 65 machines are installed in the current setup, of which 44 machines are utilized for bulk production and the other twenty one are used for sample washing. The washing machines are generally machines operated manually but sometime automatically with temperature sensor and timer. There are

automatic level sensors at front loading machines. On the other hand belly machines come with water level meters to measure the water quantity in the machines. Chemical dosing is done pneumatically. Normally two major washing processes are carried out, one for denims and other for twill.
The process flow diagram for various processes is shown in **Annexure2, Annexure3 & Annexure4**.

2.3.2 Dry Process

The dry processes of TTL are PP spray, hand scraping, laser, 3D and whisker. These processes are used to make garments appear worn and aged by scraping or folding in different areas. Dry processing generally follows different combinations of the above listed operations depending on the desired appearance of the finished garments.

2.3.3 Laboratory procedures for testing and establishing the process/sample

There is in-house laboratory where regular testing on sampling basis are carried out for PH testing, wet and dry rubbing test, tear and tensile strength of fabric etc . Examination reports for each batch are maintained for record and improvement.

2.3.4 Performance results of sample to bulk production:

The record of lab sample RFT to Bulk process RFT is very poor as per Deep dive questionnaire data and 100 % batches need topping up which is hard to believe, though the water usage data does not support this fact as average water consumption is 153 Liter/kg of production. This needs to be investigated for such low percentage and the reasons to be identified. Mainly, the lab process parameter and bulk process parameters like Liquor ratio, batch cycle time, temperature, pH, specific gravity, dyes and chemical dozing as per recipes etc. should be strictly monitored and records should be analysed when the variations are observed. Every batch which is reprocessed should be carefully investigated for root causes and if variations are found due to chemicals, procedures, manual operational mistakes or fabric quality etc. should be recorded and corrective actions to be taken for improving bulk RFT to at-least 80 % and above.

Table below summarizes the established parameters as per data available:

Table 5: Process Performance

Process Parameters	Description	Figures
Lab RFT to Bulk RFT	Lab to Bulk right first time %	0%
	% Batches topped up	100%
Re-Wash	% Batches re-dyed/re wash	0%
	% batches completed within the set programme time	Data not available
	% downgrades	< 5%
Liquor Ratio	Liquor Ratio for Bulk	1:10/1:12

2.3.5 Chemical dispensing methodology used for process:

Manual weighing and dispensing of chemical is used in lab as well as on machines. Processors use their own experience for correction of required batch variation.

2.3.6 Calibration status of dyes and chemicals weighing scales

There is no systematic procedure of regular calibration of weighing scales used in dye stores. There are no calibration procedures for the instruments on the machines for important parameters like temperature, Specific gravity or PH. Calibration records are not maintained.

2.3.7 Present resource consumption benchmark:

Based on data available in deep-dive questionnaire, following are the present benchmark for various input resources with respect to production;

Table 6: Present Benchmark

Resource	Unit	Value	Production (kg)	KPI (Key Performance Indicators)	Unit for KPI
Water	m^3	1560920	10201295	153.0	liters/kg
Chemicals	kg	1531795	10201295	150.2	gm/kg
Power	kWh	5709616	10201295	0.56	kWh/kg
NG (Total)	Nm^3	8248017	10201295	0.81	Nm^3/kg
NG (Process)	Nm^3	412401	10201295	0.04	Nm^3/kg
Steam	kg	58973322	10201295	5.78	kg/kg

2.3.8 Observations and Recommendations for improvement in wet process area

- TTL has about 100% jeans and other garment washing operations as normal routine production
- Washing process includes enzyme wash and double washing for some special garments as per client need.
- Lab to bulk first time right percentage are poor which increases use of chemicals, need for reprocess and higher resources including water, steam and energy.
- 100 % washing batches need topping up and correction which is also higher as process performance
- Normal cycle time is 1.30 Hrs for washing cycle but due to top up and correction 90-100% batches are running longer than planned program

Table 7: Process area recommendations for improvement

Sr. No.	Process area	Observations	Recommendations / Remarks
1	Washing process consistency for Lab to bulk RFT(Right first time)	Variation and reprocess needs are high between lab sample and bulk process due to various factors. 100 % batches need	• Check process/materials consistency between lab, sampling recipe and bulk production.

		topping up and correction in bulk process	• Identify the reasons why the lab to bulk RFT is so different. • Record them and try to eliminate one by one until at least over 80% is achieved • Check and monitor various parameters with sample machine to bulk lot comparing process cycle time, liquor ratio, temperature, liquor strength, water quantity etc.
2	Washing process consistency	Re-wash percentage is high .No method of continuity card for consistency of process checking	• To introduce system of continuity card with a sample piece of fabric to evaluate process consistency to reduce re-process • To conduct failure analysis to establish the reasons for inconsistency and re-wash required
3	Moisture level in fabric and garment before drying	No practice of checking moisture level after centrifuge and before sending to dryerr	Intermittent moisture level should be checked before sending garment for drying to reduce time and energy
4	Front loading Drying machines (19 Steam heated)	Exhaust air of all machines collected in common duct and going out at @ 74-80 deg C	Individual machine exhaust air should be reused in the suction at 75 deg which can be heated by gas burner further to desired temperature
5	Front loading steam heated Drying machines	Pure Condensate coming out is mixed with raw water for using as hot water	Condensate should be taken back to boiler in feed water
6	Crinkling section Ovens for drying of washed garments	Electrical heated oven with no waste heat recovery	• Ensure optimum loading and productivity • Ex gas from oven can be used for preheating of air for recirculation
7	Washing Section	Variation in sample washing machine to bulk washing batch is observed requiring extra wash or double washing which increases resources consumption	• intermittent checking of parameters is recommended • Monitor Key indicators for re-wash, energy consumption and water consumption /kg
8	Washing Section – Drum Washers	Direct steam injection for heating dilutes the washing liquor quantity due to addition of	• Indirect heating coil for steam heating may be installed and condensate to

		condensate, which can give variation in PH, SG and other chemical parameters	be collected • Calculation of condensate quantity to be added in total water quantity over the process cycle in recipe to avoid variation
9	Washing Section	Around 175 tons per month of common salt,91 tons per month of soda ash and 55 tons of other softeners are used for Desizing, washing and Scouring/bleaching which can be replaced by Enzymes and esters to reduce the chemical consumption	Use of Enzymes and Esters for reduction of chemicals in process and subsequent neutralization acid requirement in effluent can be reduced
10	The Drum washing machines operate using much higher water for each process steps	average water consumption is 80 Liters per kg of fabric washed where as overall average water consumption is 153 Ltrs/kg	• Use of water level controller and calibration of water meter to reduce water consumption • Measure and record actual liquor ratio achieved on every batch for bulk and samples batch
11	Exhaust wet process using Softeners in washing	About 55 tons per year different softeners are used for exhaust wet process	Dry softeners with zero water consumption can be tried to reduce water consumption.
12	Planned programme timing for process as per program sheet	There are large variations in programmed cycle time and actual process time in most of the batches due to need of topping up and correction	Monitor actual process times against programmed and identify the reasons if over-running is caused due to machine problems, utility reasons, individual operators, any special processes or due corrections and reprocess to match the quality
14	Dye liquor left over percentage after dyeing /rinsing	• Dyeing liquor left over percentage should be tested after every batch by dyeing small strip in lab to calculate actual dye pick up and if found more, better quality dye should be used to reduce ETP load	• the scope of reusing the mother dye bath for the repeat dyeing process in subsequent batches in the same or different machines
15	Enzyme Wash	• Separate process steps with liquor is used for enzyme wash and fading with enzymes	• Trial with single bath system where enzyme wash and fading with enzyme can be simultaneously done at low

			temperature. • This will reduce water and energy consumption and production cycle time.
16	Retrofit PLC system for monitoring parameters on drum washing machines	Total manual operation for water filling, chemical dozing, monitoring parameters and correction by trial results in variation in final quality	Water level, (auto filling and auto drain), temperature display and control and pH can be retrofitted for making process automation. Such PLC based retrofit system can be available/fabricated through local vendors costing @ 200,000 BDT per machine
17	Washing section	The machines are claimed to operate at 6:1 (both drum washers and front loaders. Normally drum washers operate at higher liquor ratio. The quoted figures for water usage (70-80 l/kg) don't match with low liquor ratios – lower consumption for simple soft washes should be much lower than 40 L/kg	• Record actual liquor ratio achieved on every batch for bulk and samples machines for exact control on water consumed • Analyze planned water use against actual water use to identify opportunities for improvement
18	Steam Dryers	Majority of steam is used in steam dryers and no condensate is returned to boiler	• To check moisture content in dried garment to avoid over drying

2.3.9 Wet Processing section CP measures action plan

CP measure no 1: Improving Lab to Bulk process performance

Project

Lab to Bulk RFT process performance improvement - RFT percentage to improve up to 80 %

Observation during audit

During the field visit it was discussed with plant personnel that lab to bulk process first time right percentage are poor. Some of the reasons are as follows:

- Correction are done by process people using individual experience
- Batch continuity card system is not maintained properly
- All examination test reports e.g. pH, wet and dry rubbing, tear and tensile strength for all batches are not generated and not maintained for each batch
- Chemicals dozing is manual and weighing scales calibration/ machine instruments calibration records are not maintained

- Direct injection of steam adds the condensate in to wash liquor quantity which is not calculated during recipe preparation
- Liquor ratio is maintained by estimation of operator, no calibration of actual measurement
- Majority batches run for longer time than planned for various reasons

Recommendation Action

- A complete package of performance improvement activities to be prepared and SOPs to be prepared and strictly followed
- By monitoring process/materials consistency between lab, sample wash and bulk production.
- Identify the reasons why the lab to bulk RFT is varying so much, record them and try to eliminate one by one until at least over 80% is achieved.
- Use of lab recipes for bulk production with proper monitoring of various parameters like process cycle time, liquor ratio, water quantity, pH, Sp. Gravity, fabric quality, chemical quality, accuracy of weights and dozes etc and compare with sample machine parameters.
- Use of proper calibrated instruments on machines for measurement of temperature, pH , Sp. Gravity, water level and accurate dozing of chemicals for each batch
- Intermittent check for liquor quality to maintain desired parameters like pH , sp. Gravity, temperature etc.
- Installing PLC based retrofit automation control for various parameters like water level, auto drain, temperature and pH where manual process control is done.

Saving Assessment

Exact cost benefit is difficult to calculate as there are multi dimensional impact of saving in all resources, improvement in productivity, reduction in water, chemical and energy etc. It can be estimated only on normative basis.

Table 8 Saving & Cost benefit for processing performance improvement

Parameter	Unit	Values
Present average annual production	kg	10201295
Present baseline water consumption	Liters/kg	153
Baseline Chemical consumption	Grams/kg	150.2
Baseline power consumption	kWh/kg	0.56
Baseline steam consumption	kg/kg	5.78
Considering improving bulk RFT up to 80 % in next Six months		
Operating Days in year	days	340
a. Water savings potential for baseline production	Liters/kg	15.3
Annual Water saving potential	m^3/year	156080
Annual water cost saving @ 5 BDT/m^3	Million BDT	0.78
b. Chemical saving potential	Grams/kg	15.02

Annual chemical saving potential	Tons/year	153.2
Average chemical cost per ton on normative basis	BDT/Ton	75000
Annual chemical cost saving	Million BDT	11.49
c. Power saving potential	kWh/kg	0.028
Annual power saving potential	kWh/year	285636
Power cost	BDT/kWh	4.08
Annual power cost saving	Million BDT	1.17
d. Steam saving potential	kg/kg	0.578
Annual steam saving potential	Tons/year	5896
Corresponding annual NG fuel saving (@ 89% Eff. and 9100Kcal/NM3 GCV)	nm^3/Year	489730
Annual fuel cost saving potential	Million BDT	2.6
Estimated total annual saving potential	Million BDT	16.0
Investment	Million BDT	20
Simple Payback	Months	15
Estimated reduction in CO2 emission	Tons/Year	1108

Action Plan

Item	Action
SOP	Prepare SOP for Lab sampling to Bulk processing and monitor strictly various parameters with record of every batch
Retrofit	PLC controller, Water meters, Calibration of machine instruments and weighing scales, Automatic dozing where applicable in Dyeing/washing machines
Procurement	From local / international vendors Installation of water meter and PLC of Belly washers, Installing other hardware for maintaining data/storage/computers
Costing	20 Million BDT
Project Specific	Bulk washing machines -44, Sample washers - 11
Baseline Parameters	Operating days – 340 No. of batches per machine per day -10
Baseline	Present performance Lab RFT to Bulk RFT – 0 %
Implication, If any & precaution	None
Social Benefits	Reduced water and other resources, reduced effluent load, improved productivity

CP measures no 2:
Project

Waterless direct softener injection spray process for reducing water consumption

Observation during audit

As shown in the annexure- 9, the detail dyeing and washing recipe for washing machine has several steps of processes for each lot of average 80 kg garment.

- Each batch process uses 6500 Liters of water with washing process
- Total water consumption for washing process works out to be 80 Liters/kg for each batch
- Softener washing process uses about 200 Liters water i.e. 2.5 Liters/kg per batch

Recommendation Action

- Use of waterless direct softener injection process can be tried using suitable technology and equipments which eliminates the use of water
- Suitable trial can be taken for small batch quantity to get desired results as the technology requires higher investment

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 9 Water less softener

Parameter	Unit	Values
Total Number of Front washing machines	Numbers	44
Machines operational	Numbers	44
Present water Consumption per batch for softening (as per data available from recipe)	Liters	200
Saving Potential with waterless softening	%	90
Saving Potential per wash cycle	Liters	180
Av No. of batches per machine per day	Nos.	8
Operating Days	days	340
Savings per machine	m^3/annum	490
Total saving from 50 % machines	m^3/annum	10780
Investment for waterless softening process equipment	Million BDT	4.0

Action Plan

Item	Action
Initial trials	Initial trials can be taken in small batches from outsources process facility available in Dhaka
Replacement	Existing water based softening process can be gradually replaced by water less process
Procurement	From European vendors(e.g. Jeanologia, Spain)
Construction	As per vendor's instruction

Costing	Estimate : 4.0 Million BDT
Project Specific	No of Front washing machines -44
Baseline Parameters	Operating days – 340
	No. of batches per machine per day -8
Baseline	Saving considered from 50% machine- 22 Nos.
	Present water consumption per batch – 200 Liters
Implication, If any & precaution	None
Social Benefits	Reduced water consumption, reduced effluent load

CP measures no 3:

Project

Retrofit of PLC based monitoring and control system for water level, auto fill and drain, monitoring temperature and pH on Belly washing machines

Observation during audit

As shown in the annexure- 9, the detail washing recipe for Belly washing machine has several steps of processes for each lot of 50 kg garment.

- Each batch process of 45 minutes uses average 7000 Liters of water with softening process
- Total water consumption for washing process is @ 85 Liters/kg and for each washing process
- Actual water level and process controller can save @ 10 % of excess water which is used by manual level estimation, estimated saving 700 Liters per batch, i.e. considering about 10 batches of for each machine per day, total water saving for 11 drum washing machines is approx. 26180 M3 per year

Recommendation Action

- Retrofit of PLC based automation system for water level control, fill and drain, temperature and pH monitoring
- Suitable trial can be taken for one/two machines first and record the water consumption before making higher investment at a time

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 10 Benefits for PLC based control for washers

Parameter	Unit	Values
Total Number of bulk washing machines	Numbers	44
No. of drum washers	Numbers	11
Present water Consumption per batch (as per data available from wash recipe)	Liters	7100
Saving Potential with PLC controller on drum washers	%	10
Saving Potential per wash cycle	Liters	710

Parameter	Unit	Values
Average Number of cycles per machine per day	Nos.	10
Operating Days	days	340
Water savings per machine	m^3/annum	2414
Total water saving from all machines	m^3/annum	26554
Investment for PLC controller	Million BDT	2.2

Action Plan

Item	Action
Initial trials	Initial trials can be taken on one / two machines from local vendors available in Dhaka
Retrofit	PLC based monitoring and control system to be fabricated for water level, auto fill and drain, temperature and pH monitoring
Procurement	From Local vendors
Construction	As per vendor's instruction and design
Costing	Estimate : 2.2 Million BDT
Project Specific	No. of Drum washing machines -11
Baseline Parameters	Operating days – 340 No. of batches per machine per day -10
Baseline	Present water consumption per batch – 7100 Liters
Implication, If any & precaution	None
Social Benefits	Reduced water consumption, reduced effluent load

2.4 Water & Water treatment Scenario

Water balance diagram for TTL is shown in **Annexure5**

2.4.1 Water and WTP (Water Treatment Plant) - Installation

Two number submersible pumps are installed by DWL to meet water requirement of process, gas engines, boilers and domestic use. Installation details of submersible pumps are tabulated hereunder.

Table 11: Submersible Pump Details

Parameters	Unit	Submersible Pump1	Submersible Pump2	Submersible Pump3
Make	-	KSB Pumps Limited	KSB Pumps Limited	KSB Pumps Limited
Model	-	-	-	-
Flow Rate	m^3/hr	120	120	120
Head	m	50	50	50

Motor Rating	kW/HP	18.5	18.5	18.5
RPM	rpm	2920	2920	2920

Performances of submersible pumps were tested by simultaneous measurement of flow, head & power. Performance results are summarized hereunder.

Table 12: WTP Plant Details

Parameters	Unit	Submersible Pump1	Submersible Pump2	Submersible Pump3
Design Flow	m^3/hr	120	120	120
Design Pressure	m	60	60	60
Motor RPM	RPM	2900	2900	2900
Motor (kW)	kW	18.5	18.5	18.5
Measured Flow	m^3/hr	76.0	92.7	76.7
Measured Head	m	45.0	44.0	45.0
Measured Power (	kW	17.7	18.1	18.1
Efficiency	%	62.1	72.1	61.0

Performances of existing submersible pumps are satisfactory hence no recommendations are made.

Apart from the above pumps TTL has also installed pumps for the water distribution system. Details of the cooling water pumps for gas generators are tabulated hereunder.

Table 13: Water Distribution Pumps

Parameters	Unit	Generator Cooling Water Pump1	Generator Cooling Water Pump2	Generator Cooling Water Pump3
Make	-	Crompton Greaves	Crompton Greaves	Crompton Greaves
Model	-	-	-	-
Flow Rate	m^3/hr	120	120	120
Head	m	30	30	30
Motor Rating	kW/HP	18.5/25.0	18.5/25.0	18.5/25.0
RPM	rpm	1475	2900	2900
Quantity	number	1	1	1

At Tusuka water quality is good hence water treatment plants are not installed.

2.4.2 Water generation, distribution - Consumption

Water generation data for raw water and soft water for last one year is collected and summarized in annexure. Ground water generation data, soft water generation data and water consumption data are shown in Annexure6.

3. Effluent Treatment Plant (ETP)

Effluent treatment plant at TTL consists of bar screen, equalization tank, flash mixing tank, flocculation tank, primary tube settler, dual media filter and sludge disposal system. Capacity of ETP1 plant is 1920 m^3/day and ETP2 plant is 2160 m3/day. Schematic diagram of the ETP is attached herewith.

Schematic in block diagram form for ETP plant is shown hereunder.

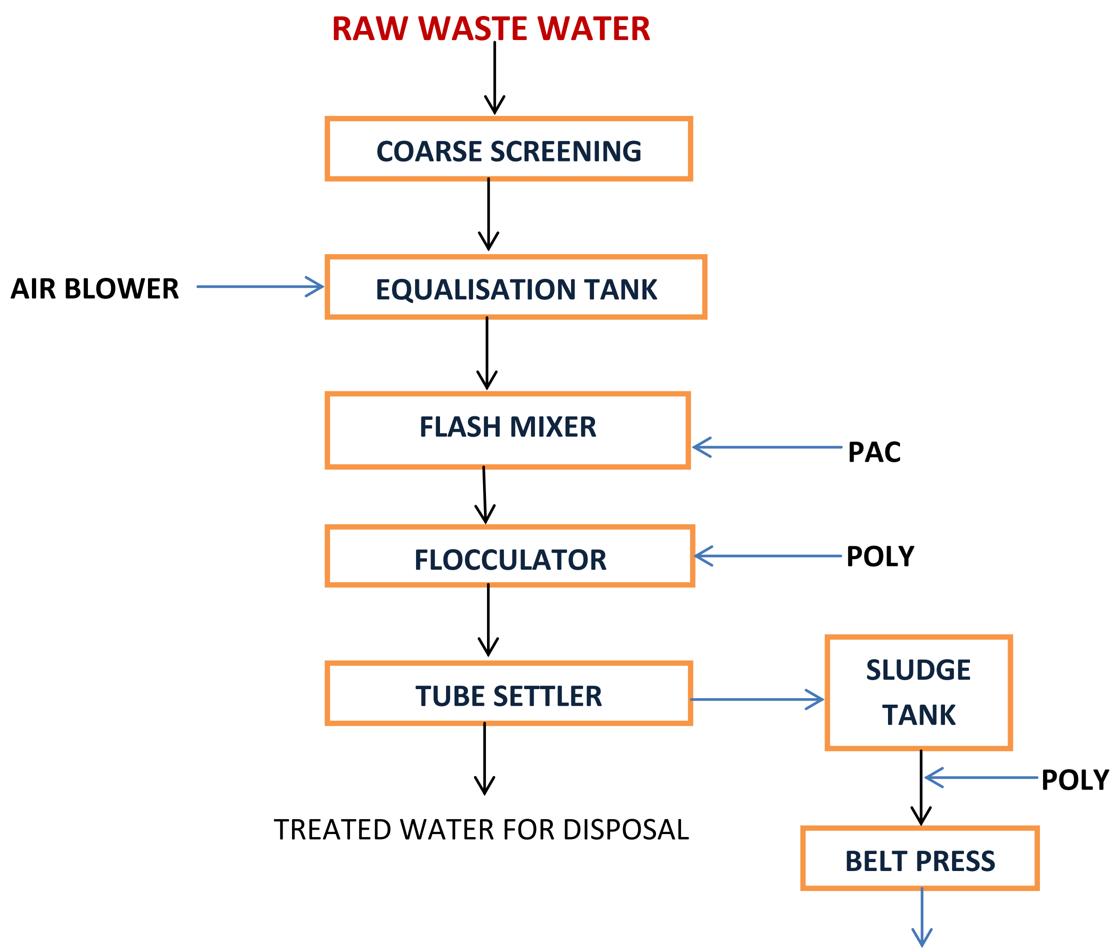

Figure 1: Schematic for ETP Plant-1

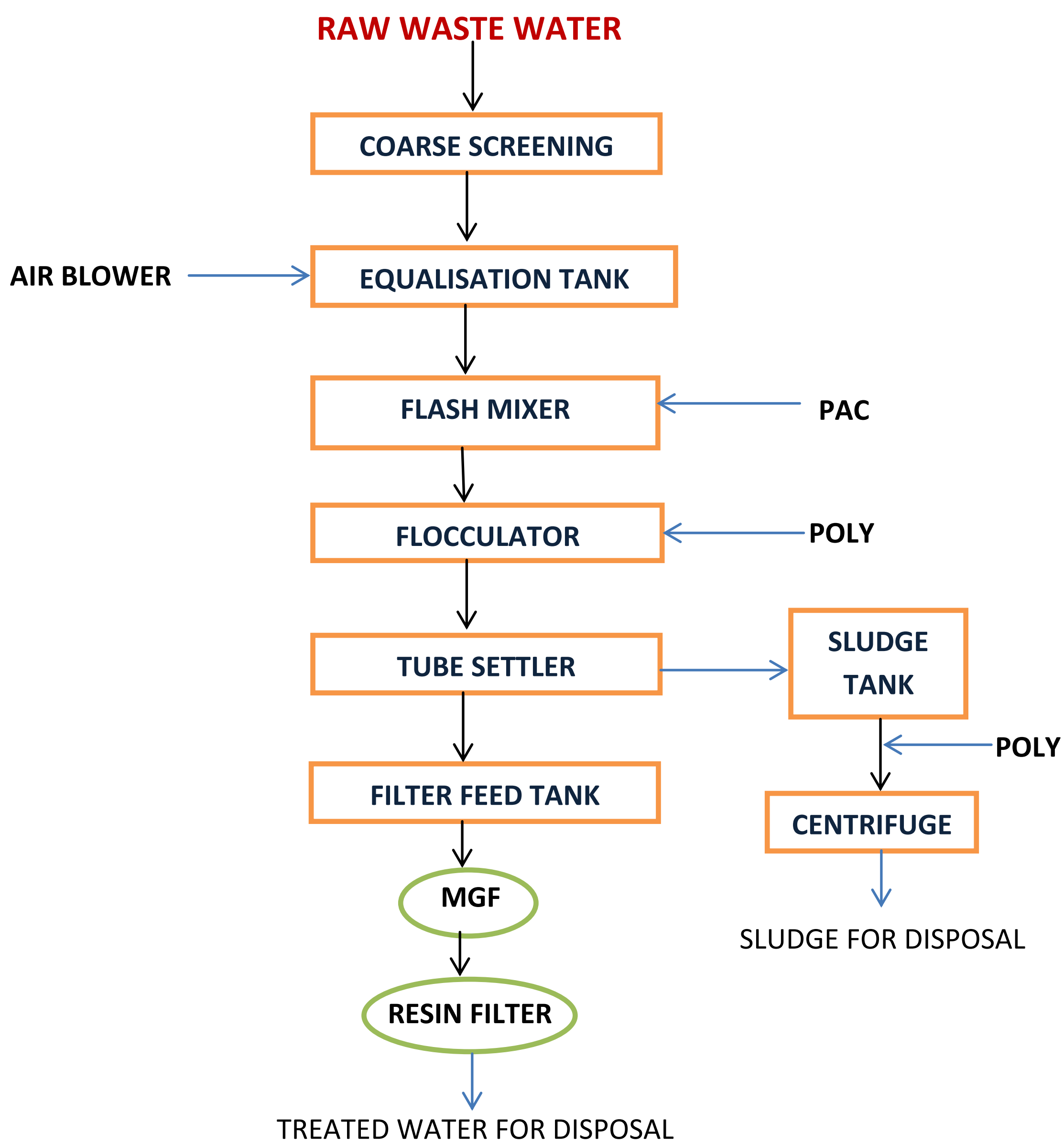

Figure 2: Schematic for ETP Plant-1

3.1 ETP design detail

Design details of ETP plant is attached as Annexure7.

3.2 Inlet and outlet effluent quantity and quality test certificate records

Inlet and outlet effluent quantity and quality parameters tested by TTL on different days along with standard norms for effluent in Bangladesh - ECR (Environment Conservation Rules) 1997 mandated by Government of People's Republic of Bangladesh, Ministry of Environment & Forest.

Table 14: ETP quantity & quality test report

Sr. No.	Parameters	Inlet to ETP1	Treated effluent ETP1	Inlet to ETP2	Treated effluent ETP2
1	PH	7.0-9.0	6.0-8.0	7.0-9.0	6.0-8.0
2	Color	Blue	Slight colored	Blue	Slight colored
3	Temperature (deg. C)	30.0 - 32.0	28.0-30.0	30.0 - 32.0	28.0-30.0
4	Suspended solids (mg/lit)	200-625	15-20	200-625	15-20
5	Dissolved solids (mg/lit)	350-650	400-500	350-650	400-500
6	COD (mg/lit)	150-650	75-150	150-650	75-150
7	BOD (mg/lit)	100-250	20-30	100-250	20-30

Observation ETP1:

Design capacity of effluent treatment plant: 1920 m3/day

Present operational load: 1600 m3/day

FIELD OBSERVATIONS:

- Overall condition of plant is not good.
- Chemical treatment not up to mark.
- Record / log sheet not maintained properly.

Observation ETP2:

Design capacity of effluent treatment plant: 2400 m3/day

Present operational load: 1800 m3/day

FIELD OBSERVATIONS:

- Overall condition of plant is good.
- Chemical treatment not up to mark.
- Record / log sheet not maintained properly.

3.3 Metering facility for effluent inlet and outlet

No metering facility is available in ETP1, whereas metering details of ETP2 are mentioned hereunder.

Table 15: ETP2 water flow meters

Sr. No.	Location	Type
1	Inlet	Online Electromagnetic
2	Outlet	No
3	Any other location	No

3.4 Metering facility at other location

No other metering available at any location in the effluent stream. All major users of fresh water should be having water flow meter e.g. Dyeing, Washing, Boiler, Administrative office block, toilet and wash lines etc.

3.5 Segregation of effluent steam

There is no segregation of effluent from various sections like softening plant, boiler blow down and effluent generated from various wet process.

3.6 Sewage generation & treatment facility

There is no record of exact quantity of sewage generated per day. The sewage is being disposed of nearby drain without any treatment.

3.7 Chemicals dosing practices in ETP

Various chemicals dosing in ETP along with quantity is summarized hereunder.

Table 16: Chemical Dosing in ETP

Chemicals	Location	Quantity (kg/day) – ETP1	Quantity (kg/day) – ETP2
PAC	Flash mixer	400	500
Polyelectrolyte	Flocculator	2	3
DE-watering Polyelectrolyte	Sludge management	1.5	2.0

It is recommended to take jar test daily once in the morning for incoming effluent to check its temperature, pH, color, DO etc. and decide the dozing of chemicals as per requirement keeping regular record of inlet water quality.

3.8 Recovery of Salt and Reuse of water

At present there is no recovery of salt nor there do any reuse of water.

3.9 Discharge Water – Prevailing norms in Bangladesh

Table 17: ECR Norms - Bangladesh

Sr. No.	Parameter	ECR 1997 Inland
1	Color	
2	pH	6.0-9.0
3	Suspended solids (mg/lit)	150
4	Dissolved solids (mg/lit)	2100
5	COD (mg/lit)	200
6	BOD (mg/lit)	50
7	DO (mg/lit)	4.5-8.0

Discharge water quality is meeting prevailing Bangladesh norms.

3.10 Disposal of sludge and hazardous chemicals

The ETP combined sludge (chemical) is disposed to nearby open land. There is no record of any quantity of sludge generated from ETP plant. Proper log record should be maintained.

3.11 Critical findings and recommendations

Table 18: ETP Findings

Equipment	Findings	ETP1	ETP2
Bar Screen	Observation	Bar screen is not adequate to handle the design flow	Bar screen is adequate to handle the design flow but it is in damaged condition.
	Impact	Larger particles not filtered out which creates problem in frequent choking of pumps.	Carryover of floating material to the equalization tank.
	Recommendations	SS Bar screen of adequate width with various spacing (15 mm, 10 mm and 5 mm) to be provided to trap the floating material.	SS Bar screen to be repaired/ replaced.
Equalization Tank	Observation	Existing tank capacity is adequate for design flow but air mixing arrangement not effective.	Existing tank capacity is adequate for design flow.
	Impact	a. No proper mixing and equalization of inlet effluent water, b. Chemical dozing becomes ineffective, c. Chemical consumption increases to get desired results.	
	Recommendations	Proper air mixing arrangement to be provided for equalization tank.	
Physio-Chemical Treatment	Observation	Rate of chemical dosing Like PAC and polyelectrolyte are not proper.	Rate of chemical dosing Like PAC and polyelectrolyte are not proper.
	Impact	Excess chemical consumption.	Chemical consumption increases to get desired results.
	Recommendations	a) Jar test to be conducted every shift to find out the optimum dosage of chemical. b) PH control system to be provided to avoid excess use of chemicals.	a. Jar test to be conducted every shift to find out the optimum dosage of chemical. b. PH control system to be provided to avoid excess use of chemicals.
Primary Tube Settler	Observation	a) Capacity of primary tube settler is adequate to handle the design flow. b) Sludge withdrawal frequency intermittent leading to carryover of sludge.	Capacity of primary tube settler is adequate to handle the design flow.

Equipment	Findings	ETP1	ETP2
	Impact	a) Chemical dozing becomes ineffective. b) Chemical consumption increases to get desired results.	Sludge withdrawal frequency to be increased (once in a 30 min) to avoid accumulation of sludge on the tube settler media.
	Recommendations	Sludge withdrawal frequency to be increased (once in a 30 min) to avoid accumulation of sludge on the tube settler media.	
Sludge Management	Observation	Existing belt press capacity is adequate to handle the total load of sludge. Proper separation of sludge is not taking place.	a) Sludge sump air mixing grid not working effectively. b) Existing mechanical centrifuge capacity is adequate to handle the total load of sludge.
	Impact	a) Sludge separation not effective. b) Excess use of poly consumption.	Accumulation of sludge in the tank.
	Recommendations	Static mixer to be provided for better separation of sludge.	a) Sludge sump air mixing grid to be replaced. b) Online static mixer to be provided for better solid separation.

Future Action Plan - Since the new effluent treatment plant is planned in future, it is recommended to segregate the low organic waste water streams like filter backwash water and softener regeneration waste from the softening plant, boiler blow down and separate treatment facility for above streams in the form of physicochemical treatment. This will reduce the hydraulic load to the ETP resulting in saving of power.

3.11.1 Issues discussed with client including review of ETP design/expansion

All the operational issues of existing ETP , problematic areas, action to be taken at each stage, importance of record keeping has been discussed in detailed with top management and supporting staff of each section.

1. Optimization of chemical dosage and importance of pH control system for physic-chemical treatment.
2. Necessity flocculation system with poly dosing before belt press.

Management is planning to install new 150 m3/day capacity effluent treatment plant based on biological and recycling of water for unit 1 , 2 and 3 near ETP unit No. 2 . Adequate space is available. Exact treatment scheme not yet finalizes.

Current ETP design and operations are capable of handling present load and discharge effluent norms.

3.12 Factory Specific baseline key indicators

Table 19: ETP effluent water characteristics

Parameters	UOM	Baseline Condition	ETP1	ETP2
Waste water parameters				
PH			7.0-9.0	7.0-9.0
Temp	Deg C		30-32	30-32
Dissolved Oxygen	mg/L		350-650	450-650
Total Suspended Solids	mg/L		200-625	200-450
COD	mg/L		150-650	250-450
BOD	mg/L		100-250	100-250
GHG reduction	T/Y			
Investment Facilitated	M BDT/USD		0.75 (9740)	0.75 (9740)
Water & Energy Management System		Not available		
Production Process		Manual Chemical dispersion		
ETP functionality / Operation		Functional but improvement required.		

3.13 Summary of CP action with proposed investment (ETP section)

Table 20: Summary of CP actions in ETP1

Present Set-up	Observations during field Study & measurements	Proposed Cleaner production action	Proposed Investment or Costing (BDT)
Bar screen	Not adequate for design load	New SS bar screen with adequate width to be installed.	75,000/-
Equalization tank	Air mixing not effective	Proper coarse diffused aeration grid to be installed.	2,50,000/-
Physio-chemical treatment	Chemical dosing not proper.	Auto chemical dosing to be provided with auto pH control system to control the chemical dosage.	3,00,000/-
Primary tube settler	Accumulation of sludge on tube settler media.	Sludge withdrawal frequency to be increased to avoid chocking of tube settler media.	
Sludge Management	Sludge separation not proper.	Flocculation system to be provided.	75,000/-

Table 21: Summary of CP actions in ETP1

Present Set-up	Observations during field Study & measurements	Proposed Cleaner production action	Proposed Investment or Costing (BDT)
Bar screen	Not adequate for design load	New SS bar screen with adequate width to be installed.	75,000/-
Equalization tank	Air mixing not effective	Proper coarse diffused aeration grid to be installed.	2,50,000/-
Physio-chemical treatment	Chemical dosing not proper.	Auto chemical dosing to be provided with auto pH control system to control the chemical dosage.	3,00,000/-
Primary tube settler	Accumulation of sludge on tube settler media.	Sludge withdrawal frequency to be increased to avoid chocking of tube settler media.	
Sludge Management	Sludge separation not proper.	Flocculation system to be provided.	75,000/-

List of venders:

1. Online pH: Forbes Marshall/ E& H
2. Blowers: key/ Usha/ Everest/ Swam (India)
3. Metering pumps : Asia LMI/Prominent/ Positive metering (India)
4. Bar screen/ static mixer: Locally fabricated.

Annexure – ETP

Table 22: ETP1 Design Adequacy

Sr. No.	Unit/ Equipment's	Capacity/ specifications	Adequacy for present load
1	Manual screen	MS bar screen	Not adequate
2	Equalisation tank	697.2 m3	Adequate
3	Raw effluent pumps	90.0 m3/hr , (2 Nos), 60 m3/hr (1No)	Adequate
4	Air blower	970 m3/hr (2 Nos)	Adequate
5	Flash mixer and floculator		
6	Primary tube settler	4.16 x4.8 x5.4 m (2 Nos)	Adequate
7	Sludge pit		
8	Sludge pumps		
9	Belt press	2500-4000 kgs	Adequate

Table 23: ETP2 Design Adequacy

Sr. No.	Unit/ Equipment's	Capacity/ specifications	Adequacy for present load
1	Manual screen	SS curved screen	Not adequate
2	Equalisation tank	693 m3	Adequate

Sr. No.	Unit/ Equipment's	Capacity/ specifications	Adequacy for present load
3	Raw effluent pumps	110.0 m3/hr , (2 Nos),	Adequate
4	Air blower	450 m3/hr (2 Nos)	Adequate
5	Flash mixer flocculator	8.0 m3 30.71 m3	Adequate Adequate
6	Primary tube settler	12.0x4.5x3.8 m	Adequate
	Filter feed tank		
	Filter feed pumps	100 m3/hr (2 Nos)	Adequate
	Sand filter followed by raisin filter	100 m3/hr	Adequate
7	Sludge Sump		
8	Sludge pumps		
9	Mechanical centrifuge	4.0-6.0 m3/hr	Adequate

4. Energy & Utility

4.1 Utility Mapping

Tusuka Trousers Limited (TTL) is mainly using natural gas for power and steam production. Natural gas is mainly used in gas engines for power generation and in steam boiler for steam generation. Some amount of natural gas is also used in process mainly for gas fired stenters. TPL uses Diesel & grid power as backup in case of non availability of natural gas. Break up of various energy sources for different application in TPL is tabulated hereunder.

Table 24: Utility Mapping

Areas	Available on Site (✓)	Water	Electricity	Gas (Direct to Machine)	Steam
Office	✓	14.0%	8%	0%	0%
Effluent Treatment Plant	✓	2.0%	4%	0%	0%
Water extraction and pretreatment	✓	3.0%	3%		0%
Washing & dryer	✓	54.0%	29%	5%	91.0%
Dry Process	✓	7.0%	4%		5.5%
Garment Manufacturing	✓	7.0%	44%	0%	3.5%
Boiler	✓	10%	3%	55%	
Generator	✓	3%	5%	40%	
Total	✓	100%	100%	100%	100%

Energy consumption from various sources of energy at TTL for last 12 months is tabulated and attached as **Annexure8**.

Percentage share of energy content resource wise is shown in pie chart hereunder.

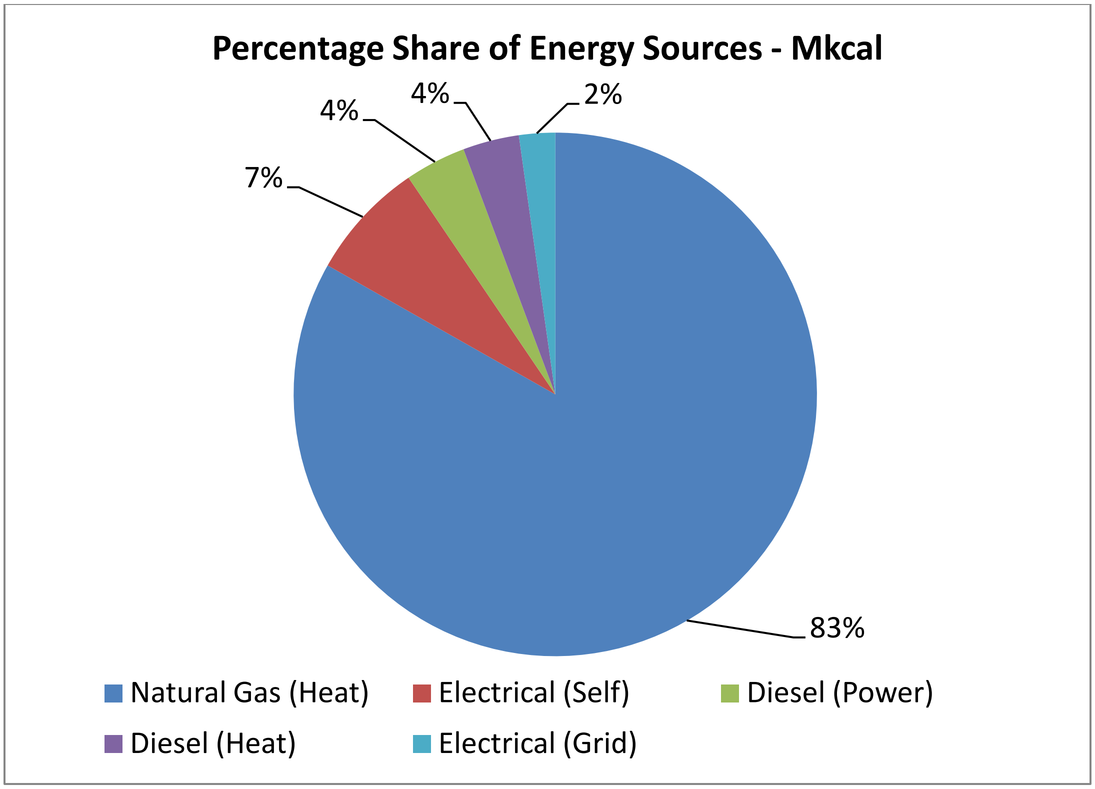

Figure 3: Percentage Share – Energy Content

For the various energy sources used in TTL the energy content, energy cost per unit of resource and total energy cost of the unit is summarized hereunder.

Table 25: Energy Content & Costing

Resource	Unit	Energy Content	Unit	Energy Cost
Natural Gas Heat	kcal/m^3	9171	BDT/m^3	5.25
Natural Gas Power	kcal/m^3	9171	BDT/m^3	4.18
Diesel Heat	kcal/liter	10080	BDT/liter	68.0
Diesel Power	kcal/liter	10080	BDT/liter	68.0
Electrical Grid	kcal/kWh	860	BDT/kWh	14.76
Electrical Self	kcal/kWh	860	BDT/kWh	4.08
Resource	**Unit**	**Quantity**	**Unit**	**Energy Cost**
Natural Gas (Heat)	m^3	4667284	BDT/annum	24503241
Electrical (Self)	kWh	4377991	BDT/annum	17862202
Diesel (Power)	liter	192489	BDT/annum	12896763
Diesel (Heat)	liter	177480	BDT/annum	11891160
Electrical (Grid)	kWh	1331625	BDT/annum	19654785
Total (BDT/annum)				86808151
Lacs BDT/annum				868.08

Percentage share of energy sources cost-wise is shown in pie chart hereunder.

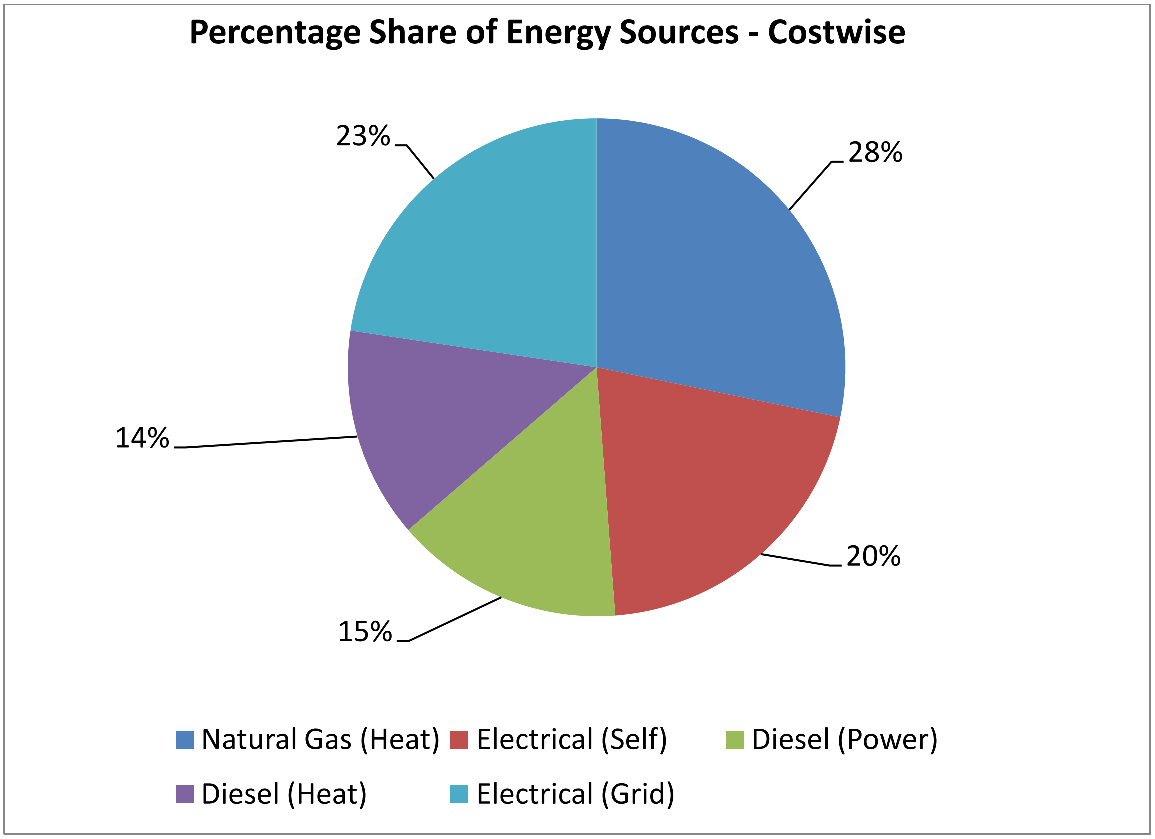

Figure 4: Percentage Share – Energy Cost

4.2 Natural Gas Consuming Equipments

Natural gas as resource is mainly consumed in various equipments for different applications. Following are the equipments in which natural gas is consumed.

Table 26: Natural Gas Consuming Equipments

Equipments	Quantity (numbers)
Generators (Gas Engines)	2
Boilers	2
Curing Oven	2
Total	6

4.3 Thermal Energy

Thermal energy in the form of steam is generated from boiler. Steam generated is mainly utilized in process for generating hot water and also used in steam dryers and steam iron machines. Installation details of boilers are tabulated hereunder.

Table 27: Installation Details of Boilers

Parameters/Boiler Tag	Unit	Gas Fired Boiler	Gas Fired Boiler	Diesel Fired Boiler	Waste Heat Recovery Boiler
Make	-	Looz	Omnical	Caldaie I.VAR	Thermax
Model	-	CE-0085	NA	I Ver	ENSG – G7

Parameters/Boiler Tag	Unit	Gas Fired Boiler	Gas Fired Boiler	Diesel Fired Boiler	Waste Heat Recovery Boiler
Type	-	Fire Tube	Fire Tube	Fire Tube	Fire Tube
Rated Output	kg/hr	5000	2500	4000	2000
Maximum Pressure	bar	11.36	9.8	11.36	8.0
Working Pressure	bar	7.0	6.5	6.5	6.5
Stack Temperature	^oC	207	102	165	120
Burner	^oC	Modulating	Modulating	Modulating	Modulating

Monthly steam generation from boilers and fuel consumption is tabulated hereunder. Two boilers are continuously running for 24 hours, they are 5.0TPH and 2.5TPH. Monthly steam generation and gas consumption data is not available.

Observations on steam generation and gas consumption are as follows:

- Common gas flow meter is installed between both the boilers.
- Gas supply is also given to gas dryers and ovens.
- We recommend installing separate gas flow meter for process equipments consuming gas.
- Separate gas flow meters to be installed for each boiler
- Once gas consumption in boiler is known then steam to fuel ratio can be monitored on daily basis.
- Steam flow meters are not installed. Steam generation is derived based on water consumption.
- Separate steam flow meters are to be installed for each boiler.

Performance evaluation of boiler was carried out through indirect method using flue gas analysis. Performance evaluation results are summarized along with measured parameters.

Table 28: Performance Evaluation of Boilers

Parameter	Unit	Boiler #1 (5.0TPH)	Boiler #2 (2.5TPH)
Calorific Value of Fuel	$kcal/m^3$	9171	9171
O_2 % in Flue gas	%	1.7	1.9
Excess Air	%	8.8	9.9
CO	ppm	0	0
CO_2	%	14.1	14.3
Fuel Consumption	m^3/hr	322.0	163.0
Ambient Temperature	^oC	35	35
Stack Temperature	^oC	193	210
Combustion Efficiency	%	84.46	83.72

4.4 Observations & Recommendations – Thermal Energy

Following are the observations & recommendations for steam & steam distribution system

- Average steam generation is 6.0-7.0 TPH.
- Oxygen level in the boiler is in the range of 1.7-2.0, which is optimum.

- For gas fired boilers optimum oxygen level should be maintained in the range of 2-3%.
- Presently blow down is done manually, frequency of blow down is 2 times per shift for about one minute.
- For each of the boiler economizers are installed to heat feed water.
- In any of the boilers there is no steam flow meters installed.
- We recommend installing steam flow meters individually in each of the boilers.
- Separate gas flow meter to be installed for boilers and gas consuming equipments in process area.
- We recommend installing individual gas flow meter on each of the boiler.
- Once separate gas flow meters are installed then for each of the boiler steam to fuel ratio is to be monitored
- Steam to fuel ratio for gas fired boiler should be around 14-15 kg of steam/m^3 of gas.
- Instead of manual blow down of water in boiler, we recommend auto blow down system for boiler.

4.5 Electrical Energy

At TTL electrical energy is mainly generated using gas engines which run on natural gas. TTL has installed two number of gas engines to meet their power requirement. These gas engines are synchronized with each other. For standby requirement there is provision of diesel engines and electrical grid. Installation details of gas engines and diesel engine are tabulated hereunder.

Table 29: Gas Engine & Diesel Engine Specification

Parameter/Gas Engine	Unit	Gas Engine	Diesel Engine	Diesel Engine
Make	-	Caterpillar	Perkins	DWIOO
Model	-	G-3516	P550-E1	EC040-2L
Quantity	-	2	1	1
Capacity	kVA	1287	550	660
Frequency	Hz	50	50	50
Voltage	V	400	400	400
Current	A	1857	794	953
Power Factor	pf	0.80	0.80	0.80

Average monthly power generation and gas consumption is tabulated hereunder.

Table 30: Monthly Power Generation and Fuel Consumption

Month	Gas Engine#1 & 2		Diesel Engine		Diesel Engine		Diesel Engine		Diesel Engine		Diesel Engine	
	NG (m^3)	kWh	Fuel (l)	kWh	Fuel (l)	kWh	Fuel (l)	kWh	Fuel (l)	kWh	Fuel (l)	kWh
Jan'14	278513	722000	510	1979	110	500	342	1500	130	540	140	450
Feb'14	311573	649000	2360	9553	185	750	1606	6500	500	1980	685	2720
Mar'14	301275	708000	990	4030	372	1500	980	4000	0	0	490	2210
Apr'14	326171	718000	5955	23457	1759	6500	3026	14250	2555	10260	3515	12060
May'14	333667	756000	7250	29051	3296	11825	3878	19250	2985	11880	4805	18180
Jun'14	315569	810000	7230	28174	923	3300	2161	11500	1550	6300	3390	11880
Jul'14	289624	615000	6080	25010	1181	4400	2041	11250	2420	9720	1485	7020
Aug'14	272335	557000	9650	38711	5470	20350	2745	15250	4080	18360	3610	14040
Sep'14	297969	580000	16400	66199	9112	37675	5623	26675	6175	25740	5515	22140
Oct'14	237182	430000	8210	33280	4152	18150	4302	23375	2280	9900	3960	16020
Nov'14	332050	800000	20100	8362	782	3300	2189	9350	680	3060	1030	4500
Dec'14	284800	780000	1140	4631	312	1375	251	996	210	900	695	3300
Total	3580728	8125000	85875	27243	27654	10962	29144	14389	23565	98640	29320	114520

Observations and recommendations:

- Gas flow meters are installed for both the gas engines.
- From the data available the present specific power generation is 2.27 kWh/m^3, which is very low for these engines.
- An efficient gas engine shall have specific power generation between 3.5-4.0 kWh/m^3
- Specific power generation also depends upon loading on gas engines, hence TTL need to check the specific norms at different load conditions
- Unit cost for the power generation from gas engine is 4.08 BDT/kWh.
- TPL has installed exhaust gas boiler in the flue gas path of gas engines.

The month-wise variation in electricity consumption is shown graphically in the figure below:

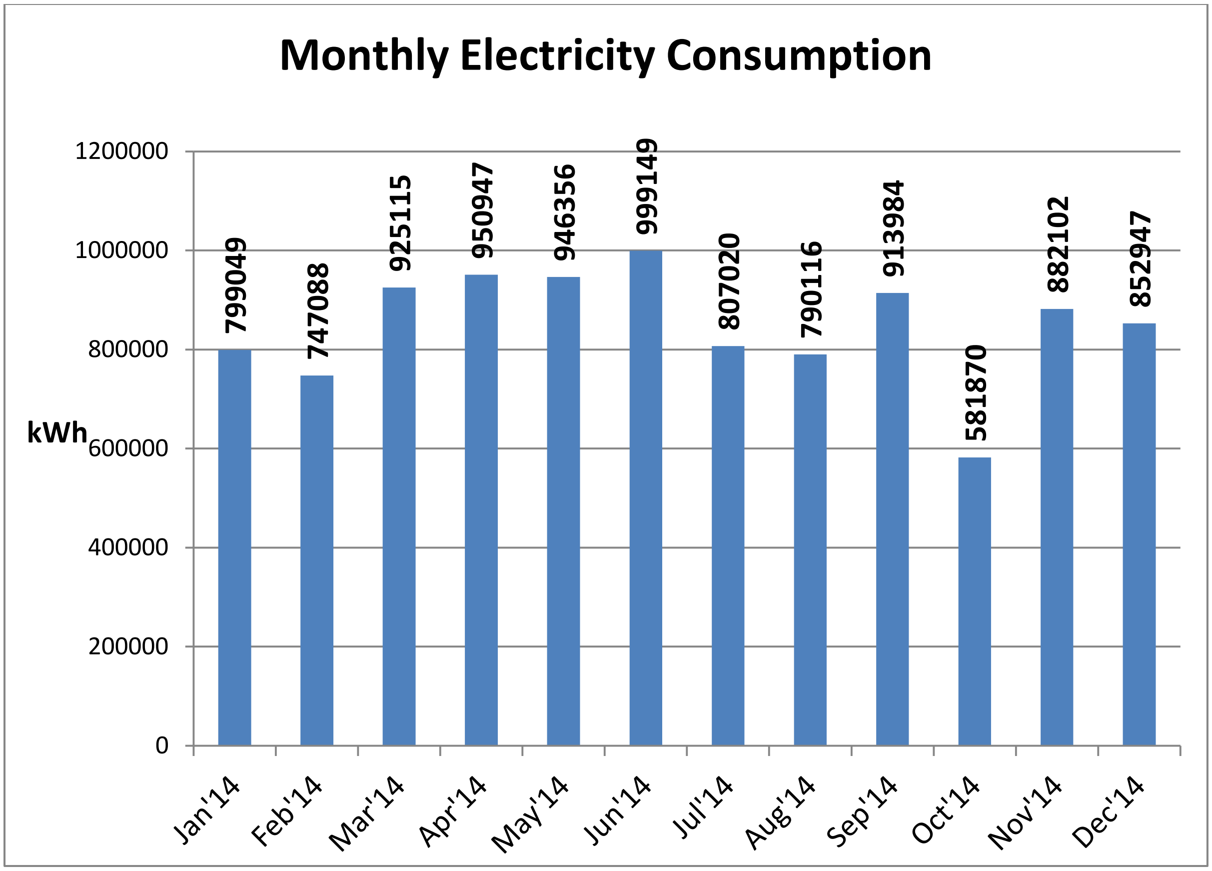

Figure 5: Monthly Electricity Consumption

Post WTA (Walk through audit) power measurements were carried out for some of the power consuming equipments. Power measurement details are summarized hereunder.

Table 31: Power Measurement

Equipment	Voltage	Ampere	kW	Power Factor
Submersible Pump1	384	41.0	24.7	0.93
Submersible Pump2	334	32.0	19.7	0.94
Submersible Pump3	396	34.0	17.0	0.96
Submersible Pump4	391	37.0	18.7	0.96
ETP2 Equalization Tank Agitator	391	18.0	9.3	0.80
ETP2 New	392	13.0	6.2	0.95
ETP2 Feed Pump	391	16.0	8.0	0.76
Compressor 75kW (Load)	396	144.0	89.1	0.89
Compressor 75kW (Unload)	397	62.0	32.3	0.89
Generator CW Pump	394	23.0	12.8	0.84
Booster Pump 11kW	398	26.0	14.3	0.84
Booster Pump 15kW	402	2.0	1.55	0.96
Steam Dryer (17.2kW)	398	16.0	10.1	0.99
Boiler (5TPH)	396	11.0	7.0	0.95

4.6 Compressed Air System

Air compressors are installed to generate compressed air which are used in process area mainly for pneumatic equipments/instruments, compressed air is also widely used in industry for cleaning purpose. Specifications of the air compresors installed at TTL is tabulated hereunder.

Table 32: Air Compressors – Installation Details

Description	Unit	Horizon	Horizon	Atlas Copco	Atlas Copco	Gardner Denver
Model	-	ELGI E75-9	ELGI E75-9	GA710	GA710	ES45-10
Type	-	Screw	Screw	Screw	Screw	Screw
Quantity	numbers	1	1	1	1	1
Discharge Capacity	CFM	467	572	388	388	229
Discharge Pressure	bar	7.13	7.65	8.16	8.16	7.13
Maximum Pressure	bar	8.5	8.0	10.0	10.0	10.0
Motor Rating	kW	75	75	55	55	45

TTL has installed five numbers air compressors. Out of these two 75kW and one 55kW are running continuously, whereas other two are catering to peak demand. Air is collected in receiver, passed through air dryer to remove moisture and then through common header air is distributed to various sections.

Observations:

- Performance of air compressors through pump up test was not possible since separate receiver was not available.
- After the walk through audit of the factory, it was decided to conduct air leakage test of the unit at suitable opportunity.
- Leakage test was conducted at TPL and it was established that air leakage are to the tune of 45% in TPL. Results of leakage test are tabulated hereunder.

Table 33: Leakage test of Compressed Air System

Parameters	Unit	Compressor 5
Average Load Time (T)	secs	33.0
Average Unload Time (t)	secs	40.0
Percentage of Leakage	%	45.2
Compressor Capacity	CFM	459
Leakage Quantity	CFM	207
Specific Power Consumption	kW/CFM	0.18
Energy lost due to leakage	kWh	37
Energy lost due to leakage	kWh/day	896

Recommendations:

- Recommend to perform regular leakage test and monitor the leakage level.
- Compressed air leakages should not be more than 15%.
- Regular pump up test can also performed to check capacity delivery.

- We also recommend installing demand controller in compressed air system after systematic study form vendor which can give saving potential in the range of 10-30%.

4.7 Factory specific Baseline Key Indicators

Factory specific baseline condition based on data provided by DWL is summarized hereunder.

Table 34: Key Performance Indicators - Factory

Resource	Unit	Value	Production (kg)	KPI (Key Performance Indicators)	Unit for KPI
Water	m^3	1560920	10201295	153.0	liters/kg
Chemicals	kg	1531795	10201295	150.2	gm/kg
Power	kWh	5709616	10201295	0.56	kWh/kg
NG (Total)	m^3	8248017	10201295	0.81	m^3/kg
NG (Process)	m^3	412401	10201295	0.04	m^3/kg
Steam	kg	58973322	10201295	5.78	kg/kg

4.8 Action plan for CP Measures – Electrical & Thermal Utilities

Based on the analysis, cleaner production actions have been identified; each of which are described below:

CP measure no 1: Energy Efficient Lighting System

Project

Install energy efficient 28W T5 lamps with electronic ballast.

Study & Investigation

During the field visit it was observed that 36W tube-lights with conventional ballast were installed in entire unit and these lamps are running 24hours. Comparisons of various lamps are shown hereunder.

Table 35: Comparison of lamps

Type of Lamp	Diameter of lamp (mm)	Lumens/Watt	Typical Life (hours)	Colour Rendering (%)
T12	38	60	5000	65
T8	26	68	8000	72
T5	16	104	20000	85

Recommendation Action

- Existing 36W tube lights with conventional ballast consume more power
- T5 lamp with electronic ballast would consume less power.
- Saving potential to the tune of 40% can be achieved.

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 36: Saving & Cost benefit for energy efficient tube lights

Parameter	Unit	Values
Total Number of 40W FTL in entire plant	Numbers	873
Present Power Consumption	Watt	52
Proposed Power Consumption	Watt	30
Saving per lamp	Watt	22
Operating Hours	hours	24
Operating Days	days	330
Savings	kWh/annum	152112
Unit Cost	BDT/kWh	4.08
Savings	BDT/annum	620615
Cost per FTL lamp	BDT	1500
Investment	BDT	1309500
Payback Period	months	25

Action Plan

Item	Action
Operation & maintenance	Electronic ballast will have less maintenance issues compared to conventional ballast, also the life of the lamp will be increased because of electronic ballast.
Retrofit	Retrofitting can be done in existing tube fittings
Replacement	None
Procurement	T5 lamp with electronic ballast
Construction	Retrofitting/replacement of existing lamps with energy efficient lamps.
Costing	Estimate : BDT 1309500
Project Specific Baseline Parameters	Unit Cost – 4.08 BDT/kWh Operating days – 330 Operating hours - 24
Baseline	Present Power consumption – 52W
Implication, If any & precaution	None
Social Benefits	Improved working conditions, reduced electricity consumption.

CP measure no 2: Reduction of leakages in compressed air system

Project

Reduction in compressed air leakages in distribution system.

Study & Investigation

During the field visit it was observed that supply pressure is kept in the range of 7.0-7.5bar, this indicates there could be substantial leakages in the system. Leakage test indicates leakages to the tune of 45%. Savings calculated by taking base of 30% leakages which can be avoided.

Recommendation Action

- Regularly perform the leakage test of the compressed air network.
- Plug all the leakages in the compressed air system.
- Compressed air is a costly utility and significant savings can be achieved by attending the air leakages.
- Compressed air leakages in a well maintained system should be between 10-15%.

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 37 Saving & Cost benefit for compressed air leakage reduction

Parameter	Unit	Values
Estimated Power Consumption for Air	kW	180
Estimated Air Demand	CFM	973
Estimated Air Leakages	%	30
Estimated Air Leakages	CFM	292
Estimated Losses	kW	54
Saving Potential (Estimated)	kWh/annum	427680
Saving Potential (Estimated)	BDT/annum	1744934
Investment	BDT	Negligible
Payback Period	months	Immediate

Action Plan

Item	Action
Operation & maintenance	Perform leakage test of the unit on a regular basis. Arrest all the leakages identified. Leakage test and leakage reduction should be regular maintenance exercise.
Retrofit	Replace air system components causing leakages

Replacement	Replace worn out pneumatic connections, joints, valves etc
Procurement	Pneumatic tubes, connectors, joints, valves etc
Construction	Not applicable.
Costing	Negligible
Project Specific Baseline Parameters	Unit Cost – 4.08 BDT/kWh Operating days – 330 Operating hours - 24
Baseline	Present Power consumption – 180kW
Implication, If any & precaution	None
Social Benefits	Improved working conditions, reduced electricity consumption.

CP measure no 3: Demand side controller for compressed air system

Project

Install demand controller for compressed air system to meet variable air requirement efficiently.

Study & Investigation

During the field visit it was observed that supply pressure is kept in the range of 7.0-7.5bar and that the air flow can be optimized by installing demand controller after doing systematic study of the compressed air system. Benefits on demand controller are summarized hereunder.

- Constant air pressure throughout the system
- Artificial demand reduction
- Reduced compressed air leaks
- Satisfy peak demand with useful storage
- Improved product quality
- Increased productivity
- Reduction in compressors operating & maintenance costs
- Payback between 7 to 22 months

Recommendation Action

- Systematic study of the unit to study the air pressure and flow pattern.
- Based on the study recommendation for demand controller along with necessary modification in distribution network.
- Saving potential to the tune of 10-30% is easily achievable.

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 38 Saving & Cost benefit for compressed air demand controller

Parameter	Unit	Values
Total Number of Compressors running	Numbers	3
Compressors Installed	Numbers	6
Present Power Consumption (Estimate)	kW	180
Saving Potential with Demand Controller	%	10
Saving Potential	kW	18
Operating Hours	hours	24
Operating Days	days	330
Savings	kWh/annum	142560
Unit Cost	BDT/kWh	4.08
Savings	BDT/annum	581645
Investment	BDT	500000
Payback Period	months	10

Action Plan

Item	Action
Operation & maintenance	No operation and maintenance issues
Retrofit	Distribution system necessary modification to install demand controller
Replacement	None
Procurement	Study of the system for 1-3 days and based on study suggestion for demand controller along with necessary modification
Construction	Installation of demand controller with necessary modification.
Costing	Estimate : BDT 500000
Project Specific Baseline Parameters	Unit Cost – 4.08 BDT/kWh Operating days – 330 Operating hours - 24
Baseline	Present Power consumption – 180kW
Implication, If any & precaution	None

Social Benefits	Improved working conditions, reduced electricity consumption.

CP measure no 4: Auto Blow down control system

Project

Auto blow down control system for optimum blow down and hence reduce energy loss through manual blow down

Study & Investigation

Manual blow down is being practiced at present. TPL gives manual blow down at the rate 2 blow down/shift for about 1-2 minutes. Manual blow down leads to loss of energy through blow down. Auto blow control system will open blow down valve only when TDS level in the water reaches the set value at which blow down is allowed. Advantages of auto blow down control system –

- Automatic timed blow down avoids wasted heat
- Adjustable blow down intervals and duration
- Repetition or omission of blow down avoided
- Valve closes on power failure
- Less water, fuel and treatment chemicals are needed
- Cleaner and more efficient boiler
- Reduced operating cost
- Minimized energy loss from boiler saves up to 2% of energy use
- Safer boiler operation and reduced labor cost

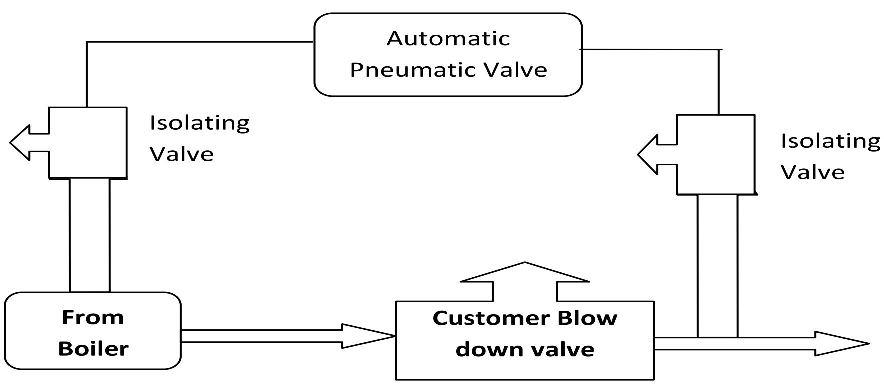

Figure 6: Auto Blow down control system

Recommendation Action

- Installation of TDS sensor to check TDS level of boiler water.
- Once the TDS level reaches the set value then automatically blow down valve opens and reduces the TDS level in boiler. Once TDS level is maintained valve closes.
- Energy losses are reduced due to auto blow down system hence saving in fuel and water to the tune of 3-5%

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 39 Saving & Cost benefit for auto blow down control system

Parameter	Unit	Values
Present Blow-down System		Manual
Number of Blow-down	Numbers	2 per shift
Present NG Consumption	m^3/hr	485
Saving in NG Consumption	%	3
Present Water Consumption	m^3/hr	6.3
Saving in Water Consumption	%	10
Saving in NG Consumption	m^3/hr	14.6
Saving in Water Consumption	m^3/hr	0.63
Operating Hours	hours	24
Operating Days	days	330
Savings in NG	m^3/annum	115236
Savings in Water	m^3/annum	4990
Cost of NG	BDT/m^3	5.25
Cost Saving (NG)	BDT/annum	604989
Cost of Soft Water	BDT/m^3	5.00
Cost Saving (Water)	BDT/annum	24948
Total Saving	BDT/annum	629937
Investment	BDT	500000
Payback Period	months	10

Action Plan

Item	Action
Operation & maintenance	Installation of auto blow down control system to maintain optimum TDS level in boiler and blow down valve opens only when TDS level reached set value. Once the TDS level is maintained valve automatically closes.
Retrofit	Install TDS sensor along with pneumatically operated valve as a blow down system
Replacement	Arrangement is to be made in the blow down line to install TDS sensor along with blow down valve
Procurement	TDS level sensor, blow down valve, air supply for pneumatic valves
Construction	Necessary fabrication work to install TDS sensor along with valve in the blow down pipe line.

Costing	Estimate BDT 500000
Project Specific Baseline Parameters	Cost of natural gas 5.25 BDT/m^3 Operating days – 330 Operating hours - 24
Baseline	Present water consumption – 6.3 m^3/hr Present fuel consumption – 485 m^3/hr
Implication, If any & precaution	None
Social Benefits	Improved working conditions, reduced natural gas consumption.

CP measure no 5: Heat recovery from jacket water to generate hot water

Project

Generate hot water by utilizing heat from jacket water.

Study & Investigation

Presently heat from jacket water is released into cooling tower. We recommend installation of additional PHE (Plate heat exchanger) and recover heat from jacket water to generate hot water. This hot water can be utilized in process.

Recommendation Action

- Install one more PHE in parallel to existing PHE and use it to generate hot water as and when required.
- When demand for hot water is not there the existing PHE will be inline and release the jacket water heat into cooling tower.
- Hot water generated through jacket water heat will reduce steam consumption and hence saving in natural gas consumption.

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 40 Saving & Cost benefit for jacket water heat recovery system

Parameter	Unit	Values
Engine Capacity	MW	1.03 x 2
Number of Engines Running	Numbers	2
Present Operating Load	kW	1480
Heat Available for Recovery	kW	427

Parameter	Unit	Values
Hot Water Recovery	m^3/hr	9.2
Operating Hours	hours	24
Operating Days	days	330
NG Saving	m^3/hr	50
Unit Cost	BDT/m^3	5.25
NG Saving	$m^3/annum$	396410
Savings	BDT/annum	2081154
Investment	BDT	1700000
Payback Period	months	10

Action Plan

Item	Action
Operation & maintenance	Install additional PHE in parallel to existing PHE and recover heat from jacket water to generate hot water as and when there is demand.
Retrofit	Install PHE, piping, pumps, tanks etc
Replacement	PHE installation, piping, insulation, automation system, hot water tank etc
Procurement	PHE, piping, valves, insulation, tanks etc
Construction	Necessary fabrication work to install additional PHE with necessary piping, pumps, tanks, insulation etc
Costing	Estimate BDT 1700000
Project Specific Baseline Parameters	Cost of natural gas 5.25 BDT/m^3 Operating days – 330 Operating hours - 24
Baseline	Hot water generated using steam.
Implication, If any & precaution	None
Social Benefits	Improved working conditions, reduced natural gas consumption.

CP measure no 6: Feed Water tank insulation

Project

Insulate feed water tank to avoid heat loss taking place.

Study & Investigation

During the field visit it was observed that feed water near exhaust gas boiler (EGB) was found un-insulated. And the surface temperature was about 96°C.

Recommendation Action

- We recommend insulation of feed water tank to avoid heat losses.
- Surface temperature after insulation should not be more than 45-50°C.
- Quality rock wool insulation shall be used for insulation.
- Density of insulation material shall be about 30-50 kg/m^3.
- Thickness of insulation shall be minimum 40mm.

Saving Assessment

The cost-benefit analysis of the project is as shown in the table below:

Table 41 Saving & Cost benefit for feed water tank insulation

Parameter	Unit	Values
Diameter of tank	m	1.5
Length of tank	m	2.5
Surface Area of Feed Tank	m^2	11.8
Surface Temperature	°C	96
Ambient Temperature	°C	40
Surface Heat Losses	kcal/hr/m^2	68.8
Total Heat Loss	kcal/hr	811
Operating Hours	hours	24
Operating Days	days	330
Heat Losses	kcal/annum	6420237
Annual Fuel Savings	m^3/annum	875.07
Savings	BDT/annum	4594
Investment	BDT	4000
Payback Period	months	10

Action Plan

Item	Action
Operation & maintenance	Once surface is insulated it will have a life of minimum 3 years subject to atmospheric condition.
Retrofit	No retrofit
Replacement	Insulate the entire bare surface of feed water tank

Procurement	Insulation material, aluminium cladding, GI wires etc
Construction	To hold the insulation small metal clits are to be welded.
Costing	Estimate BDT 4000
Project Specific Baseline Parameters	Cost of Natural gas 5.25 BDT/m^3 Operating days – 330 Operating hours - 24
Baseline	Existing heat loss – 811 kcal/hr Present surface temperature – 96^{o}C.
Implication, If any & precaution	None
Social Benefits	Improved working conditions, reduced natural gas consumption.

5. Summary of CP measures in Utility area

5.1 Electrical energy consumption areas

Table 42: CP measures for Electrical System

Name of Area	Present Set-up	Observations during field Study & measurements	Proposed Cleaner production actions
Lighting System	36 Watts tube-lights installed in entire factory	Mostly these tube lights are running even in day time	Recommend replacing 36W tube lights by 28W energy efficient T5 lamps with electronic ballast
Compressed Air	Used in process	It was observed that number of compressed air leakage points are there in the unit	We recommend regular monitoring of compressed air network and arrest leakages on regular basis.
Compressed Air	Compressed air is passed through dryer, receiver and finally to application areas	It was observed that very high pressure is maintained to meet the process air requirement.	Installation of demand controller prior to distribution may optimize air consumption and lead to saving to the tune of 10-30%. Systematic study will reveal the scope of saving opportunity.

5.2 Thermal energy consumption areas

Table 43: CP measures for Thermal System

Name of Area	Present Set-up	Observations during field Study & measurements	Proposed Cleaner production actions
Heat recovery from jacket water of gas engine	No heat is recovered from jacket water. Heat from jacket water is released in cooling tower.	There is substantial heat available in jacket water to generate hot water which is process requirement.	Install one more PHE (Plate type heat exchanger) in parallel to existing PHE for jacket water heat recovery and hence generate hot water
Blow down control in Boiler	Manual blow down is practiced at present.	Presently blow down is given manually at the rate, 2 times/shift for about 1-2 minutes.	Install auto blow down control system which will sense TDS level in boiler and accordingly blow down control valve will operate.
Boiler feed water tank	No surface insulation on feed water tank	Surface temperature measured on feed water tank is 96°C.	Recommend insulation of feed water tank to avoid heat loss and to maintain surface temperature close to 45-50°C.

6. Implementation Plan

6.1 Vendor Interactions

The details of vendor interaction carried out for this project are as follows:

- Heat recovery systems on gas engines
- Compressed air demand side controller

6.2 Project costing

The process followed for arriving at the project costing involved the interaction with various vendors by sending them technical data sheet for technical design and commercial prices. The summary table of project cost is as shown in the following table:

Table 44: Project costing

CP No	CP	Major Items	Basic Price	Excise Duty	CST	Service Tax	VAT	P&F	Transit Insurance	I&C	Total

Installation and Commissioning – 10% is indicative; can vary depending on measure.

6.3 Implementation Timeline

6.4 Process downtime and training needs

The estimated process down time for implementation of each CP and pre-operation training needs are as follows:

Table 45: Process down time and Training need

CP	CP	Process Downtime for	Pre-Operation Training Needs

No		CP Implementation (Days)	Operator	Maintenance Team	Senior Management

7. Conclusions and Recommendations

The study has helped successfully identify cleaner production actions which when implemented will help bring down the GHG reduction of the unit by **28.93%**. These measures have an estimated investment of **57.02 Million BDT** and can yield a savings of **26.6 Million BDT**.

Annexure1 – Plant and Machinery Details

Table 46: Machines & Equipment Details

Sr. No	Machine	Quantity	Year of Manufacture
1	Bulk Washer	44	-
2	Sample Washer	21	-
3	Hydro Extractor	11	-
4	Steam Dryer	19	-
5	Gas Dryer	-	-
6	Generator	4	-
7	Boiler	3	-
8	Compressor	4	-

Annexure2 – Denim Washing Process

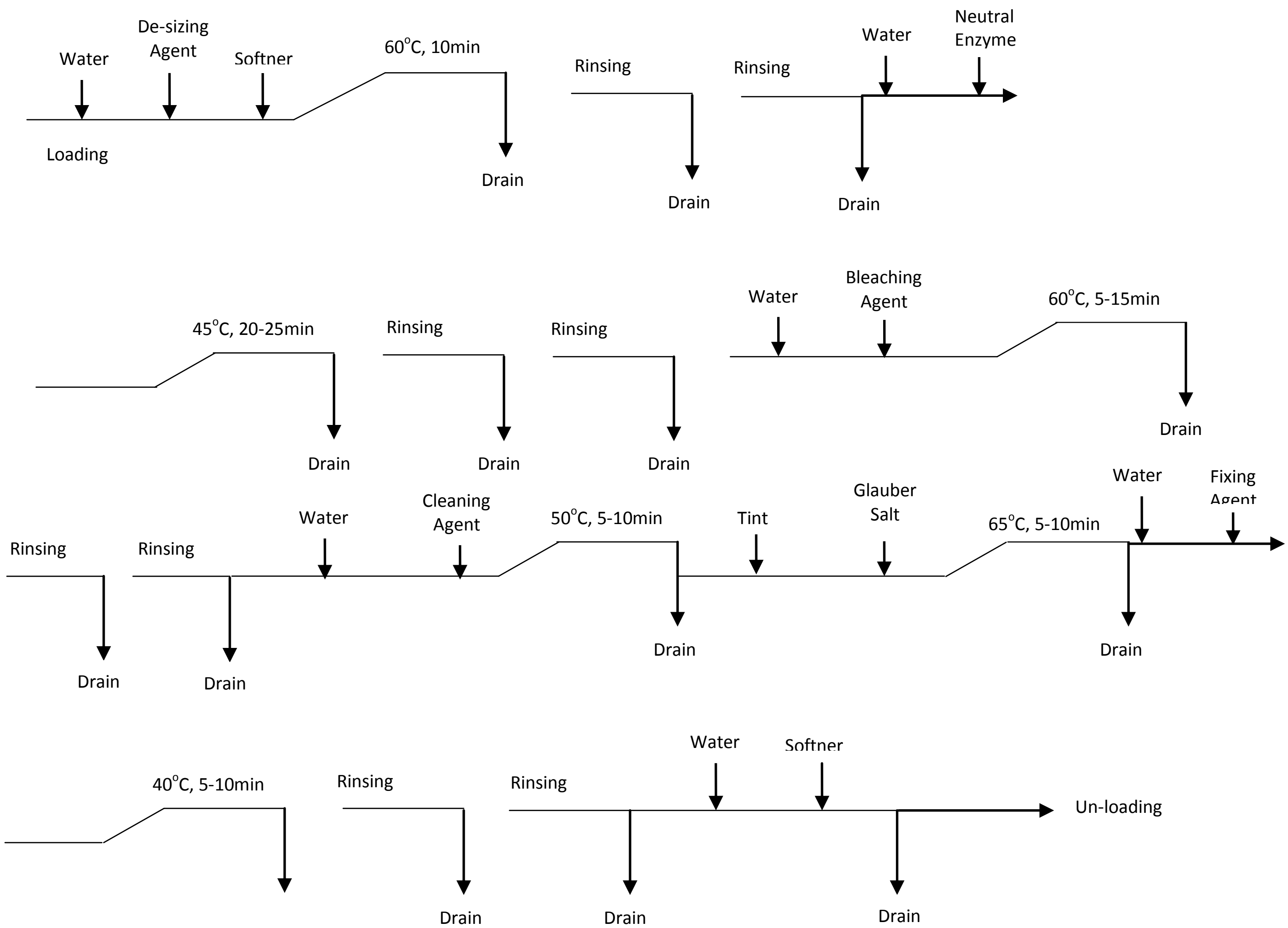

Figure 7: Denim Washing Process

Annexure3 – Ordinary Washing Process

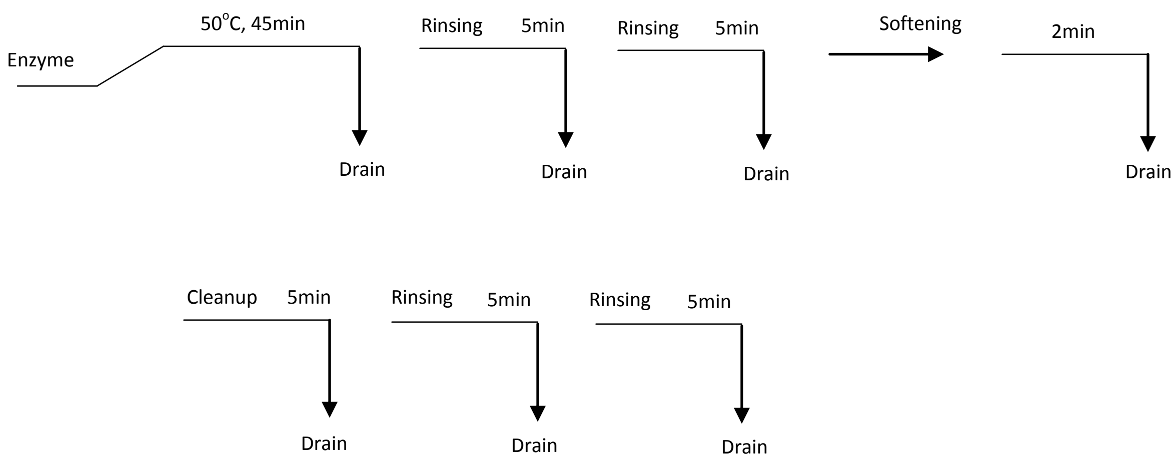

Figure 8: Ordinary Washing Process

Annexure4 – Process Flow Diagram

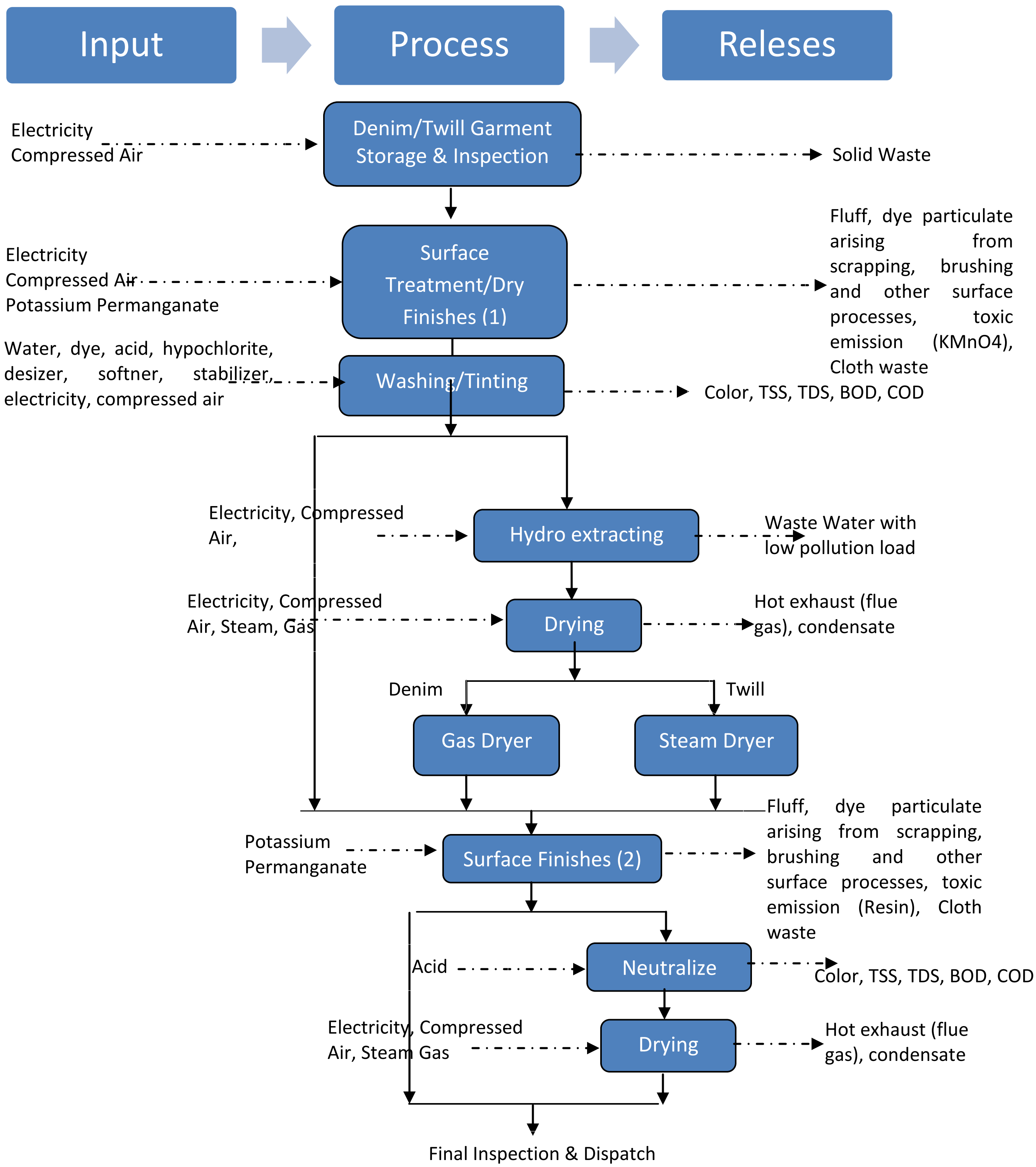

Figure 9: Process flow diagram of TPL

Annexure5 – Water Balance Diagrams

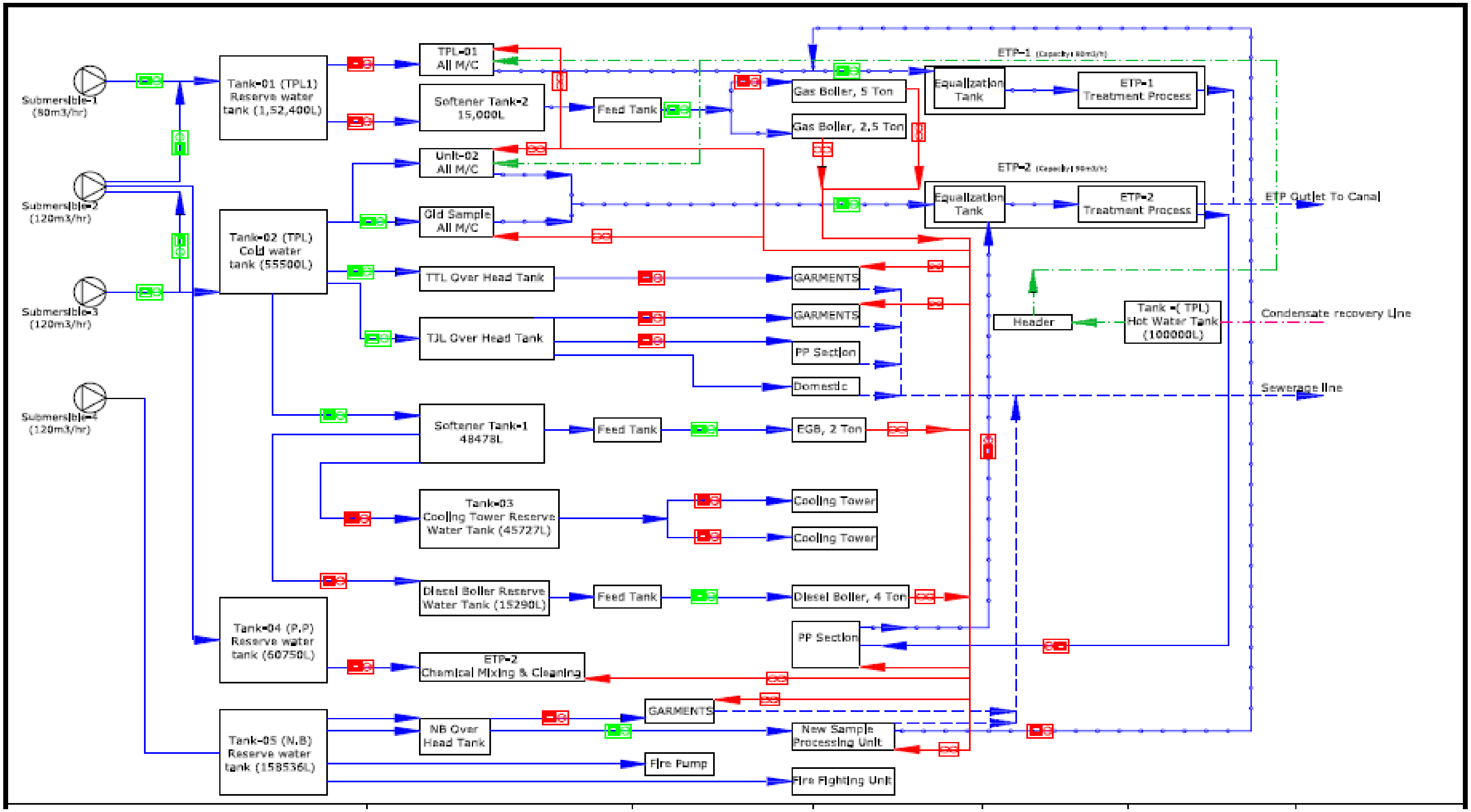

Figure 10: Water balance diagram of TTL

Annexure6 - Ground water & Soft water generation, Water Consumption data

Table 47: Ground Water generation data

Month	Unit	Ground Water
Jan'14	m^3	139752
Feb'14	m^3	115409
Mar'14	m^3	142830
Apr'14	m^3	134854
May'14	m^3	144352
Jun'14	m^3	133984
Jul'14	m^3	116548
Aug'14	m^3	117864
Sep'14	m^3	147673
Oct'14	m^3	100257
Nov'14	m^3	142941
Dec'14	m^3	124456
totals (year)	m^3	1560920

Water consumption in various sections as per the details provided by DWL is summarized hereunder.

Table 48: Water consumption data

Month	Unit	Domestic, Boiler & Others	Wet Process	Boiler	Generator
Jan'14	m^3	19797	119955	-	-
Feb'14	m^3	13614	101795	-	-
Mar'14	m^3	13043	129787	-	-
Apr'14	m^3	10093	124761	-	-
May'14	m^3	12517	131835	-	-
Jun'14	m^3	10350	123634	-	-
Jul'14	m^3	11515	105033	-	-
Aug'14	m^3	17273	112808	-	-
Sep'14	m^3	25993	115932	-	4087
Oct'14	m^3	19549	83168	-	3276
Nov'14	m^3	26690	110259	-	4556
Dec'14	m^3	25176	94672	-	4878
Total (Years)	m^3	205610	1353639	0	16797

Annexure7 – ETP design details

Table 49: ETP design details

Sr. No	Particular	Details (Unit1/Unit2)	Unit
1	**Chemical used in the process**	$FeSO_4$, Lime, polymer, color removing agent	
2	**Total Industrial water demand**	2000/1800	m^3/day
3	**Waste water generated from various section**		m^3/day
3a	Peak flow and duration		
3b	Lean flow & duration		
3c	Avg. flow	1700/1600	m^3/hr
4	**Domestic waste water**	Quantity not Available	m^3/day
5	**Total waste water**	1700/1600	m^3/day
6	**Raw waste water characteristics**		
	PH	8.5-9.0/7.0-9.0	
	Color	Blue/Blue	
	Temperature	30-35 (both)	Deg.
	Oil & Grease	< 5ppm	mg/lit
	Suspended solids	<450/200-625	mg/lit
	Dissolved solids	450-650/350-650	mg/lit
	COD	550/150-650	mg/lit
	BOD	250/-	mg/lit
7	**Treated waste water characteristics**		
	PH	6.5-8.5/6.5-8.5	
	Color	Slight Colored (both)	
	Temperature	<30 (both)	Deg.
	Suspended solids	<30 (both)	mg/lit
	Dissolved solids	Details not available	mg/lit
	COD	<200 (both)	mg/lit
	BOD	<30 (both)	mg/lit
	Effluent treatment plant capacity	2400/1920	m^3/day
	Present Operation Load	240	m^3/day
	Sewage treatment	Discharge to Nalla without treatment	
8	**Effluent Treatment scheme Adapted**		
8a	**Physical Separation**		
	Screen (Yes/No)	Yes	
	Type	Manual Curved Screen/Manual	
8b	**Equalization**		
	Tank Capacity (Size)	693.0/697.2	m^3
	Type of mixing	Air Mixing	
	Blower capacity/Installed power	450/970	m^3/hr
	Raw effluent pumps (30 HP)	110(2)/90(2), 60(1)	m^3/hr
	Primary Treatment		

Sr. No	Particular	Details (Unit1/Unit2)	Unit
	Flash mixer (Yes/No)	Yes	
	Capacity/ Size	8/-	m^3
	Flocculator (Yes/No)	Yes	
	Capacity/ Size	30.72/-	m^3
	Electro-coagulation		m^3
	Primary Clarifier/ plan settling/tube settler/Lamella settler	Tube Settler/Tube Settler (2)	
	Capacity	205.2/13	m^3
	Size	12x4.5x3.8/4.16x4.8x5.4	m x m x m
8d	Chemical used		
	PAC	500/400	kg/day
	$FeSO_4$($FeSO_4$-1750kg+alum 500kg)/day	-	kg/day
	Poly	3/2	kg/day
	Type of feeding (Manual/ Pumping)	Through Pumping	
8e	pH Correction facility (yes/No)	No	
	Capacity		m^3
	Chemical used ($FeSO_4$ + Alum)		kg/day
	Type of feeding (Manual/ Pumping)	Through Pumping	
9	**Biological Treatment (Yes/No.)**	No biological system in the present scheme.	
9a	**Type of system**		
	Tank Capacity		m^3
	Homogenization tank		m^3
	Anaerobic tank		m^3
	Aerobic tank		m^3
	Feed pump Capacity		m^3/hr
	Mode of aeration (Aerator/ Diffused aeration		
	Installed power/ blower capacity		m^3/hr
	DAP/ Urea dosing system(Yes/No)		
	Performance of aeration system		
9b	**Secondary settling tank**	None	
	Clarifier/ plain settling/ tube settler	Clarifier	
	Size		
	Capacity		m^3
	Recirculation Pumps		m^3/hr
9c	**Chlorine contact tank (Yes/No)**		
	Capacity/Size		m
9d	**Biological sludge pit**		
9e	**Sludge Thickener**	No	
10	**Tertiary system (Yes/No)**	No	
	Capacity	2400/-	m^3/day
	Units involved	MGF followed by Scawanger/-	

Sr. No	Particular	Details (Unit1/Unit2)	Unit
	Capacity/size	100 each	m3/hr
	Utility point	Discharge to Nalla	
11	**Sludge Management**		
	Type (Sludge drying beds/Mech. De-watering system)	Sludge Decanter (Humbolt make)/Belt Press	
	Capacity/ size	4.0-6.0m^3/day/2500-4000kgs	
	Chemicals used for dewatering	Polyelectrolyte	
	Chemical Consumption	2.0/1.5	kg/day
12	Overall performance of the plant	Existing system is working satisfactorily	
13	Future expansion plan	Planned to put new ETP of capacity 150 m3/hr For unit 1 & 3 adjacent to ETP-2.	
14	Instrumentation Installed	Electromagnetic flow meter at the delivery line of raw effluent pump. /No flow meters to measure the quantity of effluent being treated.	
15	Observation	Rate of chemical dosing in primary treatment not proper. Jar test to be conducted every day to find out the chemical dosage.	
		Manual screen damaged, need to replace.	
		Air mixing grid in the sludge tank damaged, need to replace.	
		Primary sludge withdrawal rate intermittent. Data of sludge withdrawal rate not available.	
		Dewatered sludge quantity data not maintained.	
16	Recommendation	Proper chemical dosage (PAC & poly) in primary treatment by conducting Jar test to avoid excess use of chemicals.	
		Proper chemical dosage (PAC & poly) in primary treatment by conducting Jar test to avoid excess use of chemicals.	
		Installation of flow meter at the outlet of treatment plant	

Annexure8 – Energy Consumption Details

Table 50: Energy Consumption

Month	Natural Gas Heat (m^3)	Natural Gas Power (m^3)	Diesel Heat (Liter)	Diesel Power (Liter)	Electrical Grid (kWh)
Jan’14	431595	278513	35670	1222	72080
Feb’14	469757	311573	17050	5336	76585
Mar’14	433164	301276	12305	2832	205375

Month	Natural Gas Heat (m^3)	Natural Gas Power (m^3)	Diesel Heat (Liter)	Diesel Power (Liter)	Electrical Grid (kWh)
Apr'14	453791	326171	7300	16810	166420
May'14	408603	333667	10720	22214	100170
Jun'14	411007	315569	3070	15254	127995
Jul'14	363118	289624	8510	13207	134620
Aug'14	289465	272335	33140	24555	126405
Sep'13	329344	297970	24360	40825	155555
Oct'13	312413	237183	16740	22877	51145
Nov'13	394654	332051	2545	24781	53530
Dec'13	370374	284800	6070	2576	61745
totals (year)	**4667284**	**3580733**	**177480**	**192489**	**1331625**

Annexure9 – Process Recipe

TUSUKA PROCESSING LTD

Konabari, Gazipur

Revised

Buyer: C / Four
Style: I 550738 (Indigo)
Lot qty: 2480 Pcs+ 1280 Pcs
Factory: TTL
Item- M.D.L.P

Date: 30.03.15
Job Order No- 055.03.15

Un Wash Shade

Wash type: Desize+Enzyme+Bleach+Tint+PP Neutral+Softener

Wash Shade

Bulk Production Recipe

100 PCS

Batch lot qty: 100 pcs/70kg

Step	Process	Chemicals	Dosege(gm)	Water(Ltr)	Temp(C)	Time(min)
1	Desize	Amylase Multi Conc	13	400	50	20
		GW 704 S	200			
2	Rinsex1			500		3
3	Enzyme	Power Wash Total	500	400	45	20
		GW 704 S	300			
4	Rinsex2			500		6
		Remove Tacking				
5	Bleach	Bleach Cl- 65%	1000	500	50	20
6	Rinsex1			500		3
7	Neutral	Arcotex Conc	200	400	50	10
		GW 704 S	200			
8	Rinsex1			500		3
9	Tint	Brown GTL	10	250	50	10
		Yellow RL	2			
		Salt	1000			
		Send to PP spray				
		Batch lot qty: 100 pcs				
10	Neutral	Soda Ash	500	400	50	7
		H/Oxide	500			
		GW 704 S	100			
11	Rinsex1			500		3
12	PP Neutral	Arcotex Conc	200	400	45	10
		GW 704 S	100			
13	Rinsex1			500		3
14	Tint	Brown GTL	2	250	45	2
		Yellow RL	0.2			
		Salt	1000			
15	Softener	Siliflex NAM	500	200	R/T	2
		Citric Acid(pH 4.5)	250			
		Total=		**6200**		**122**

Shift Incharge A.P.M P.M D.Manager Fac.Manager R & D Manager

TUSUKA PROCESSING LTD
KONABARI, GAZIPUR

Revised

DATE: 27.03.15
JOB NO: 046.03.15

Buyer : H&M
Style : Friday Instant Blue (Blue)
O/ QTY : 4797 Pcs
P.O: 345810-8302 Blue
Factory: TTL
Item: M.D.L.P

Un Wash Shade

WashType: Desize+Enzyme+Bleach+PP Neutral+Tint+Softener

Wash Shade

Bulk Production Recipe

100 Pcs

Batch Lot Qty: 100 Pcs/70 kg

Step	Process	Chemicals	Dosege(gm)	Water(Ltr)	Temp(C)	Time(min)		
1	Desize	Amylase Multi Conc	8	400	60	15		
		GW 704 S	300					
2	Rinsex1			500		3		
3	1st Enzyme	Power Wash Total	1000	350	45	40		
		GW 704 S	400					
		P. Stone (used)	62500					
4	Rinsex1			500		3		
		Remove Taking & Stone						
5	Avol PL	Avol PL	100	400	R/T	5		
6	Bleach	Bleach Cl- 35%(KCl)	3000	400	60	20		
	(5 check)	Soda Ash	1500					
7	Rinsex2			500		6		
8	Neutral	H/Oxide	1000	350	50	5		
		GW 704 S	200					
9	Rinsex1			500		3		
		Send to All over PP + Granding						
		Batch Lot Qty: 100 Pcs						
10	PP Neutral	Arcotex Conc	1000	350	R/T	5		
		GW 704 S	200					
11	Rinsex1			500		3		
12	Bleach	Bleach Cl- 65%	100	500	45	5		
13	Rinsex1			500		3		
14	Neutral	Soda Ash	500	400	50	10		
		H/Oxide	800					
		GW 704 S	200					
15	Rinsex1			500		3		
16	Tint	Brown GTL	2	250	45	5		
		Yellow RL	0.4					
		Black VSF	0.6					
		Salt	1000					
17	Softener	Siliflex NAM	500	200	R/T	2		
		Serafast C-NC	500					
		Citric Acid(pH 4.5)	400					
		Total =		**7100**		**136**		

Shift Incharge A.P.M D.Manager Fac Manager R & D Manager

Revised

Buyer: H&M
Style: Slim Icy Wash Short SO (Blue Light)
O. QTY: 13314 Pcs
P.O No: 791900-5686: Blue Light
Factory: TTL
Item: M.D.S.P
WashType: Desize+Enzyme+Bleach+PP neutral+Tint+Softener

JOB NO: 018.02.15

Un Wash Shade

Wash Shade

150 Pcs

Bulk Production Recipe

Batch Lot Qty: 150 Pcs/100kg

Step	Process	Chemicals	Dosege(gm)	Water(Ltr)	Temp(C)	Time(min)
1	Desize	Soda ash	1000	400	60	15
		GW 704 S	100			
2	Rinsex1			500		3
3	1st Enzyme	Blue Breeze Multi	600	400	45	30
		GW 704 S	400			
4	Rinsex1			500		3
5	2nd Enzyme	Blue Breeze Multi	400	400	45	20
		GW 704 S	300			
6	Rinsex1			500		3
7	Bleach	Bleach Cl 35%(KCl)	2000	500	50	15
8	Rinsex1			500		3
9	Neutral	H/Oxide	1000	400	40	8
		GW 704 S	200			
10	Rinsex1			500		3
		Send to pp Spray				
		Batch Lot Qty: 130 Pcs/80kg				
11	PP Neutral	Arcotex Conc(solid)	500	400	40	10
		GW 704 S	200			
12	Rinsex1			500		3
13	1st Neutral	H/Oxide	1000	400	55	7
		Special White S.O	100			
		GW 704 S	100			
14	Rinsex1			500		3
15	2nd Neutral	Arcotex Conc(solid)	200	400	R/T	10
		GW 704 S	100			
16	Rinsex1			500		3
17	pH Control	Citric Acid(pH 4.5)	170	400	R/T	2
18	Tint	Brown GGL	1	300	R/T	6
		Red BWS	0.1			
		Salt	500			
19	Softener	Softy Finish Ok New	1000	200	R/T	2
		Citric Acid(pH 4.5)	100			
		Total=		8200		149

04/03/15

04/03

Shift Incharge | A.P.M | P.M | D.Manager | Fac Manager | R & D Manager

TUSUKA PROCESSING LTD
KONABARI, GAZIPUR

DATE: 17.02.15
JOB NO: 031.03.15

Buyer : EL CORTE INGLES
Style: 56323 B3 (Navy)
O/ QTY : 11500 Pcs
Factory: TFL
Item: M.D.L.P

Un Wash Shade

WashType: Enzyme

Wash Shade

100	PCS

Bulk Production Recipe
Batch Lot Qty: 100 Pcs/70kg

Step	Process	Chemicals	Dosege(gm)	Water(Ltr)	Temp(C)	Time(min)		
1	Enzyme	Power Wash Total	300	200	R/T	4		
		GW 704 S	200					
2	Rinsex2			500		6		
		Total=		700		10		

17.03.15

S/B [illegible] A.R.M P.M D. Manager Fac Manager R & D Manager