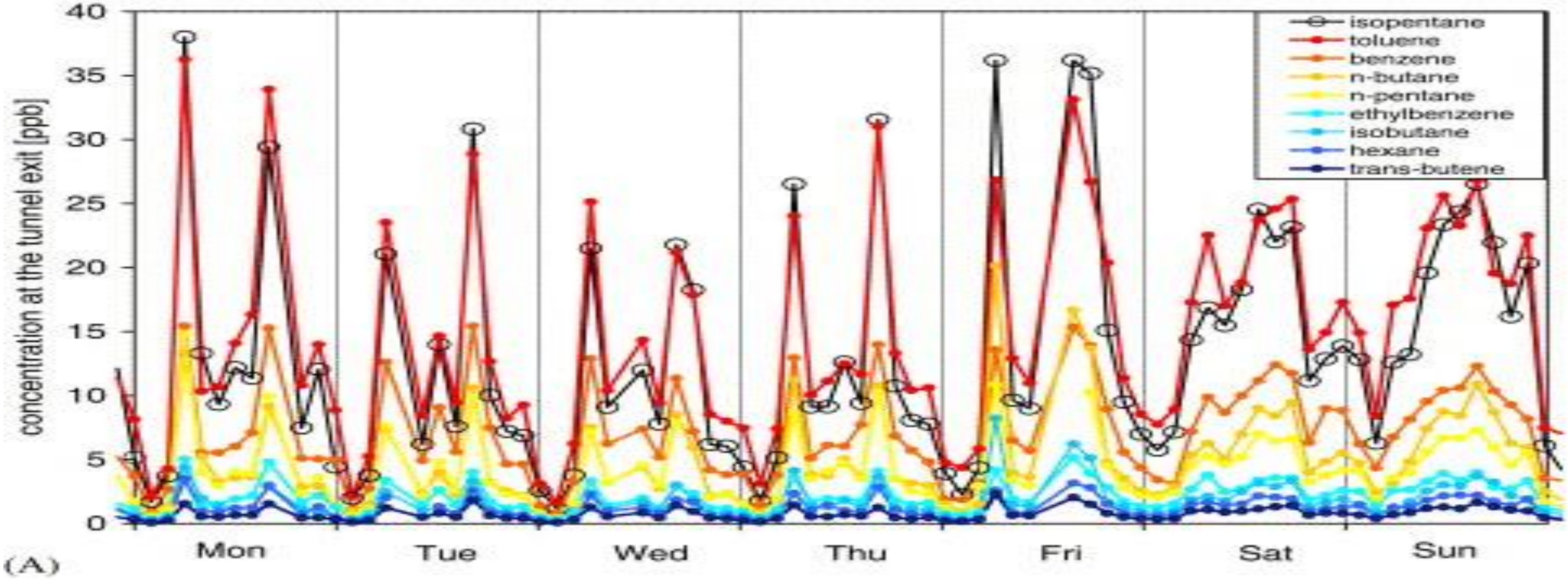
Ambuja Cement

Strength. Performance. Passion.

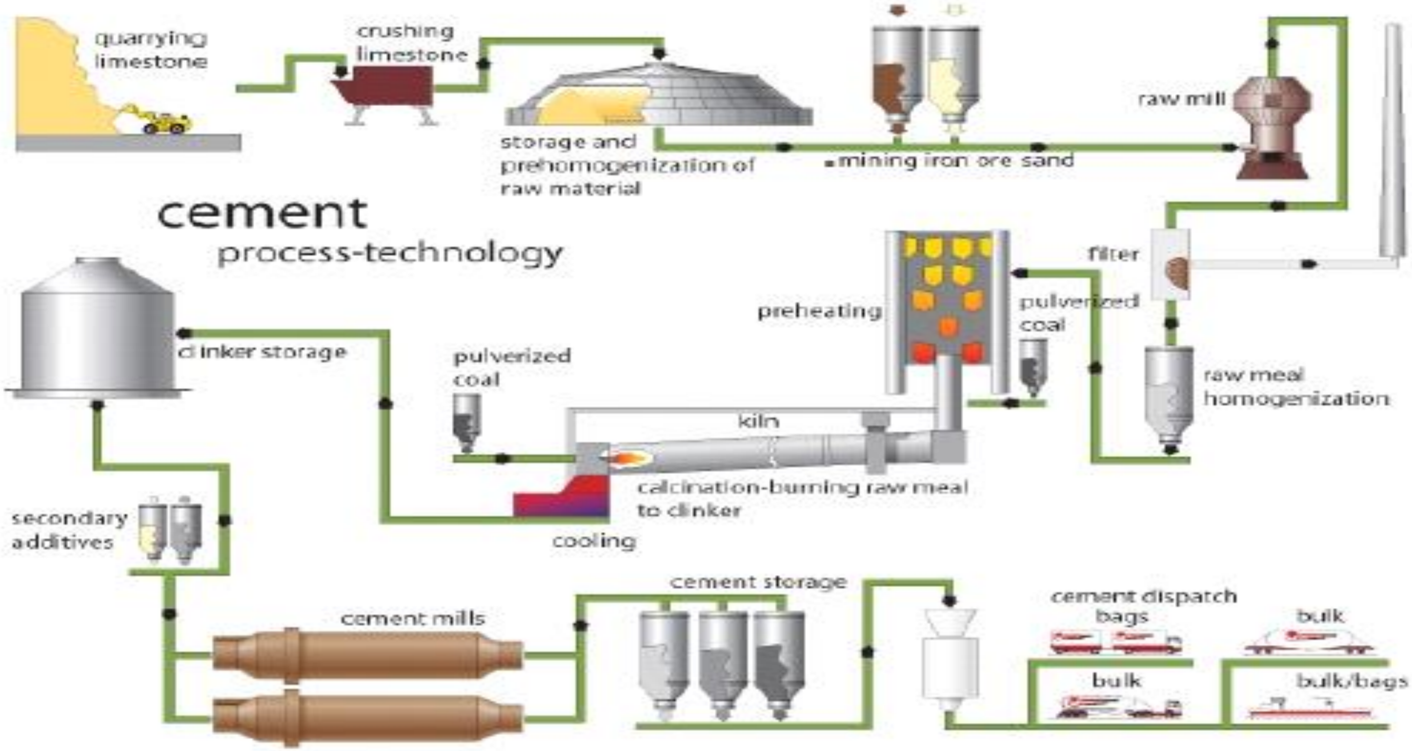
Process, Resource Impacts



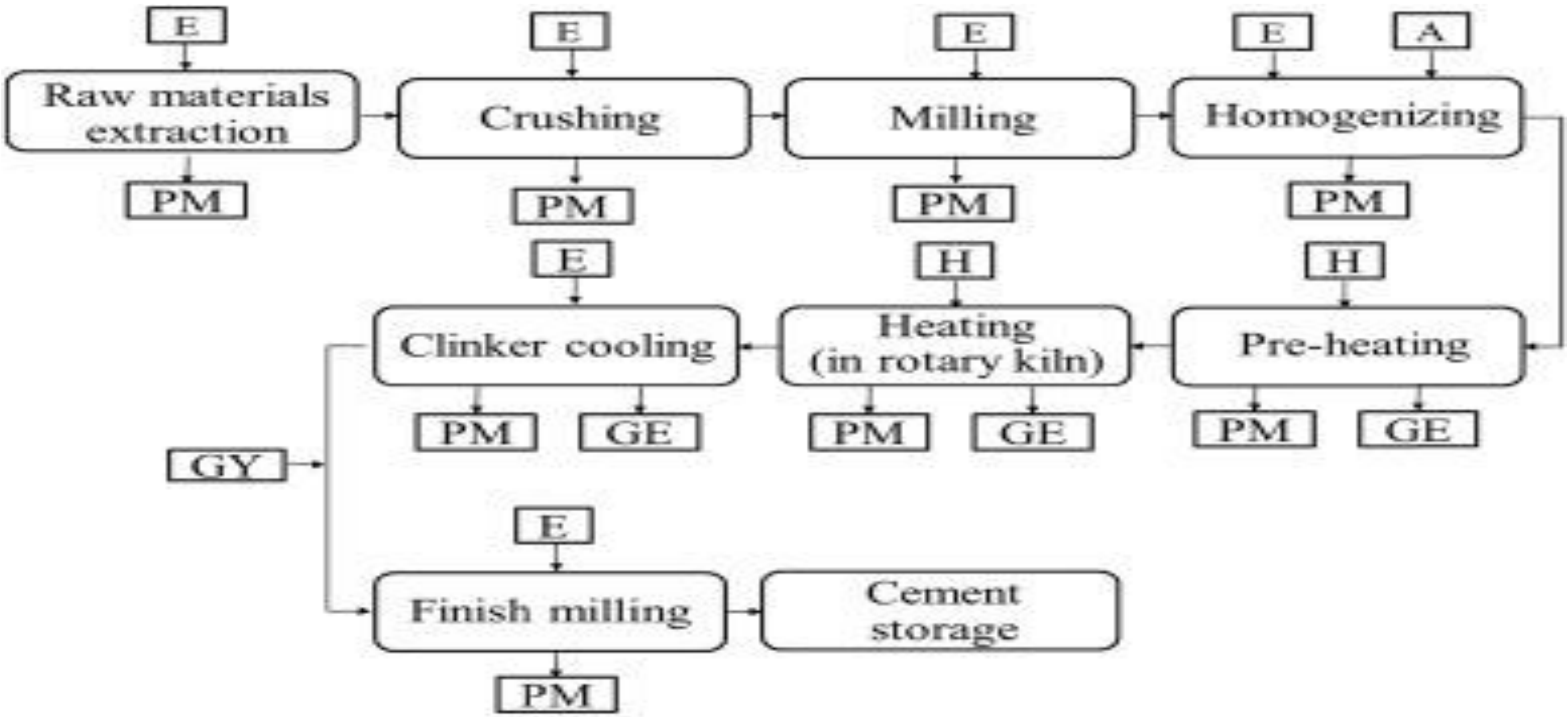
PROCESS DESCRITION & INPUT OUTPUT FLOW

- What steps are involved in the process?
- Controls process implemented in accordance with procedures Input an Output details

Flow Sheet Cement Manufacturing Process



Input Output Flow sheet- Cement Manufacturing



Inputs:
E – Energy
A – Additions (slag, pozzolans)
H – Heat
GY – Gypsum

Outputs:
PM – Particulate matter
GE – Gaseous emissions

PROCESS OUTPUT AND MEASUREMENT

- Product produced by this process?
- Equipment used for process Calculations.
- How are processes measured?
  - Mass Balance, Energy Balance
  - LCA for carbon balance per kg of product for each process
  - Emissions to air and water
    - SOx NOx measurement & Preventions
  - False Air measurement
  - Alkali Sulphur Calculation

Processes Monitoring and Measurement

Ambuja Cements Ltd. has applied suitable methods for **monitoring** processes. These methods demonstrate the ability of the processes to achieve planned results. When planned results are not achieved, **corrections and corrective actions are taken**, as appropriate, to ensure conformity of the product.

Monitoring and measuring instruments are calibrated or verified at specified intervals or prior to use against measurement standard if no such standard exist, the basis used for calibration is recorded.
Records of the results of calibration/or verification are maintained.

PROCESS AUDITS

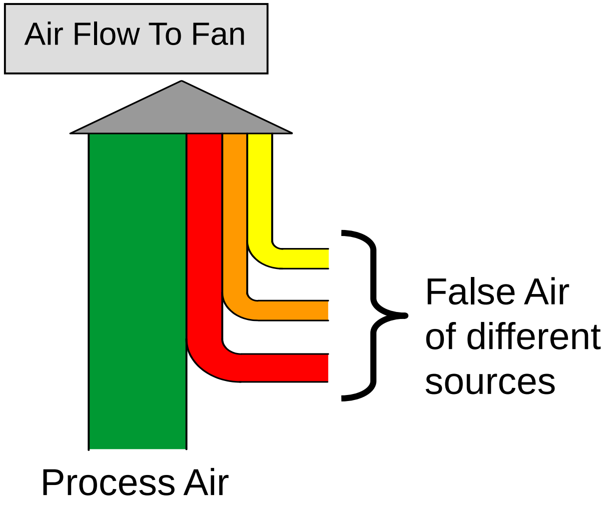
Technical audit is a review of all units of plant equipment to determine their operating efficiencies with relation to original design and to subsequent modifications. Current performance is compared to what is realistically achievable and for this purpose 'rated' or guarantee capacities should not be taken uncritically.

The purpose is to establish the efficiency with which the plant is being operated, to identify bottlenecks and to propose means of eliminating them 'Debottlenecking' is a cost effective technique for increasing productivity.

- Establish optimum mix design with respect to **cost, handling, grindability** and **burnability** .
- Produce constant **chemical** and **physical** input material characteristics .
- Operate equipment with minimum **process variations** and optimum efficiency
- Finish grind to a product having best possible **strength** with minimal variation.

False Air Inspection

Instead of leaking out from within the process, there is now a problem with ambient air being sucked into the system, called false air. Depending on the point of entry, false air has different undesired effects. That is why a lot of effort is made to keep process systems tight.



Main Impacts of False Air

- Increase Thermal Energy Consumption
- Reduced drying capacity
- Reduced production (lower air speeds)
- Increased energy consumption of fan motor
- Corrosion (Operation below of or close to dew point temperature)
- Filter Overload

False Air Directly Relates the Thermal Energy Consumption and Power Consumption.

Mass Transfer & Heat Transfer Calculation in Kiln

The kiln system has to be designed to cope with the requirements of the chemical process during which the kiln feed material is converted into cement clinker.

This process as a whole is endothermic and takes place at maximum material temperatures of **1450°C**. Receiving its thermal energy from hot gases of up to 2000°C generated by combusting fuels, it is also referred to as **PYROPROCESS**

For Gas flow measurement these Common techniques used are demonstrated and applied:

1) **Prandtl Tube:** The velocity will be measured on several points of the cross sectional area by means of which the average velocity and the volume rate will be calculated**(Quaterly).**

2) **Anemometers:** At the outlet of the test equipment the mean velocity will be measured **(Quaterly).**

3) **Fan Characteristics:** With the knowledge of the characteristic curves of the fan given by the supplier, the volume rate is determined by the pressure difference of the fan and the revolutions of the fan**.(Yearly)**

4) **Inlet Nozzle (Piezometer):** At the suction side of the fan an inlet nozzle is attached . Data continuously monitored.

Sample MT sheet For One Of The Plants

KILN AUDIT HEAT BALANCE TOOL - MATERIAL BALANCE RESULTS

	Material Balance Based on Clinker Weighing		Material Balance Based on Kiln Feed	
	t / h	kg/kgck	t / h	kg/kgck
Kiln Feed (dry)	329.27	1.65	328.77	1.65
Kiln Feed (dry + TOC + S^{-2})	329.53	1.65	329.04	1.65
Kiln Feed (wet+TOC+S^{-2})	330.69	1.66	330.20	1.66
Total Fuel Ash	0.88	0.00	0.88	0.00
Total Fuel SO_3	2.38	0.01	2.38	0.01
Total Fuel Cl	0.02	0.00	0.02	0.00
Σ	332.55	1.67	332.04	1.67
Clinker	199.55	1.00	199.23	1.00
Preheater Dust	27.38	0.14	27.38	0.14
Bypass Dust	0.00	0.00	0.00	0.00
SO_2 in preheater exit	0.00	0.00	0.00	0.00
Dehydration+Decarbonation	105.62	0.53	105.42	0.53
Σ	332.55	1.67	332.04	1.67

Elemental Balance Based on Clinker Weighing		
Clinker [%]	Measured	Calculated
SiO_2	20.08	19.58
Al_2O_3	5.55	5.60
Fe_2O_3	3.49	3.49
CaO	65.33	65.83
MgO	2.13	2.13
LOI	0.55	0.55
CO_2	0.26	0.26
K_2O	0.57	0.64
Na_2O	0.41	0.44
SO_3	1.55	1.28
TiO	0.33	0.32
P_2O_5	0.00	0.00
Cl	0.02	0.03
Σ	99.72	99.62

Kiln feed wet / clinker	1.66		1.66
Raw mix dry / clinker	1.51		1.51

Factor kilnfeed / clinker for production:	1.65
Error of kiln feed scale:	0.15%

Note:
T/h-tonnes per hour
Kg/kgck- kiloGm per KiloGm of Clinker (Factor)

Sample HT sheet For One Of The Plants

KILN AUDIT HEAT BALANCE TOOL - FUEL SUMMARY

Kiln Specific Heat Consumption, (SHC), kJ/kgck	**3383**
SHC including TOC and S^{-2}, kJ/kgck	**3422**

			Neutral Waste Gases		
Main Burner Fuels	Flowrate, kg/h	LHV, (kJ/kg - as fired)	Nm³/kgck	Nm³/MJ	Ratio over kiln SHC, %
pet coke	8058	33[illegible]00			39.7%
Fall Through					
Preheater / Precalciner Fuels					
pet coke	11261	33300			55.5%
biomass	2410	13167			4.7%
TOC	234	33830			
S^{-2}		13120			

Note:
Fuel mix calculation done every fortnight.
kg/h-KiloGms per hour
TOC-Total Organic Carbon
KJ/Kgck-Kilo joule per Kilo Gms Clinker

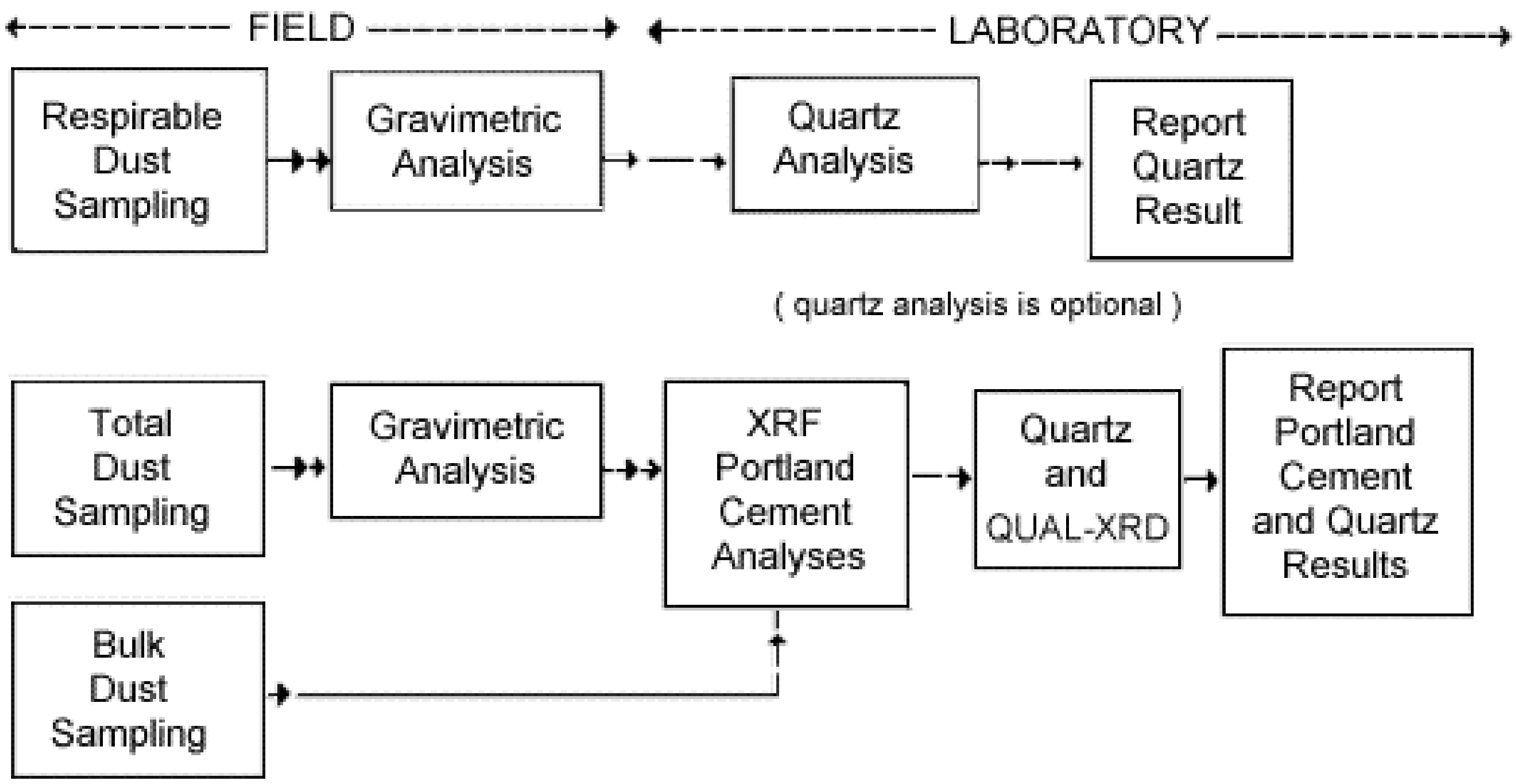
Sample HT sheet For One Of The Plants (continue..)

System In					
	kg/h	T°C	Nm3/kgck	kJ/kgck	heat%
Kiln Feed	329265	65			
H_2O	1164	65			
Total Fuel	21963				
Sensible Heat	21306				
Combustion	21306				
H_2O	423				
TOC Combustion	234	65			
S^{-2} Combustion		65			
Total False Air					
Total Primary Air	#NAME?	#NAME?			
Total Cooling Air of Cooler	#NAME?				
Total Water Injection	1189	#NAME?			
SNCR		0			

System Out						
	content	kg/h	T°C	Nm3/kgck	kJ/kgck	heat %
Preheater Exit Gas			390			
Gas Composition						
CO_2						
H_2O						
SO_2 (ppm)						
N_2						
O_2						
CO						
Heat Loss CO Preheater Exit						
Cooler Exhaust Air			290			
Cooler Exhaust Inj. Water Vap.						
Cooler Mill Take Off #1		#NAME?				
Cooler Mill Take Off #2		#NAME?				
Clinker-Cooler Exit		#NAME?	160			
Clinker Dust - Tertiary Air Dedusting		#NAME?	854			
Clinker Dust - Exhaust Gas		#NAME?	290			
Clinker Dust . Cooler Mill take off 1 + 2		#NAME?				
Clinker Formation Heat						
Preheater Dust		27383	379			
By-Pass Gas						
By-Pass Dust						
By-Pass Decarbonisation Heat						
Water Vaporization SNCR						
Water Vaporization Preheater Injection						
Water Vaporization Feed Moisture		1164				
Wall Losses					268.52	
Tertiary Air Duct					8.00	
Preheater					165.01	
Kiln					80.81	
Cooler					14.70	

Note:
- **All Temperature measure in degree Celsius.**
- **System in and out temperature calculations**

Analysis of Quantitative Air Samples- PPC unit



NOx Emission in Pyroprocess

Thermal NOx

=> high temperature (>1600°C)

=> oxidation of N_2 from ambient air

=> f (temperature, gas composition, residence time,...)

$N_2 + O_2 \Rightarrow 2\ NO$

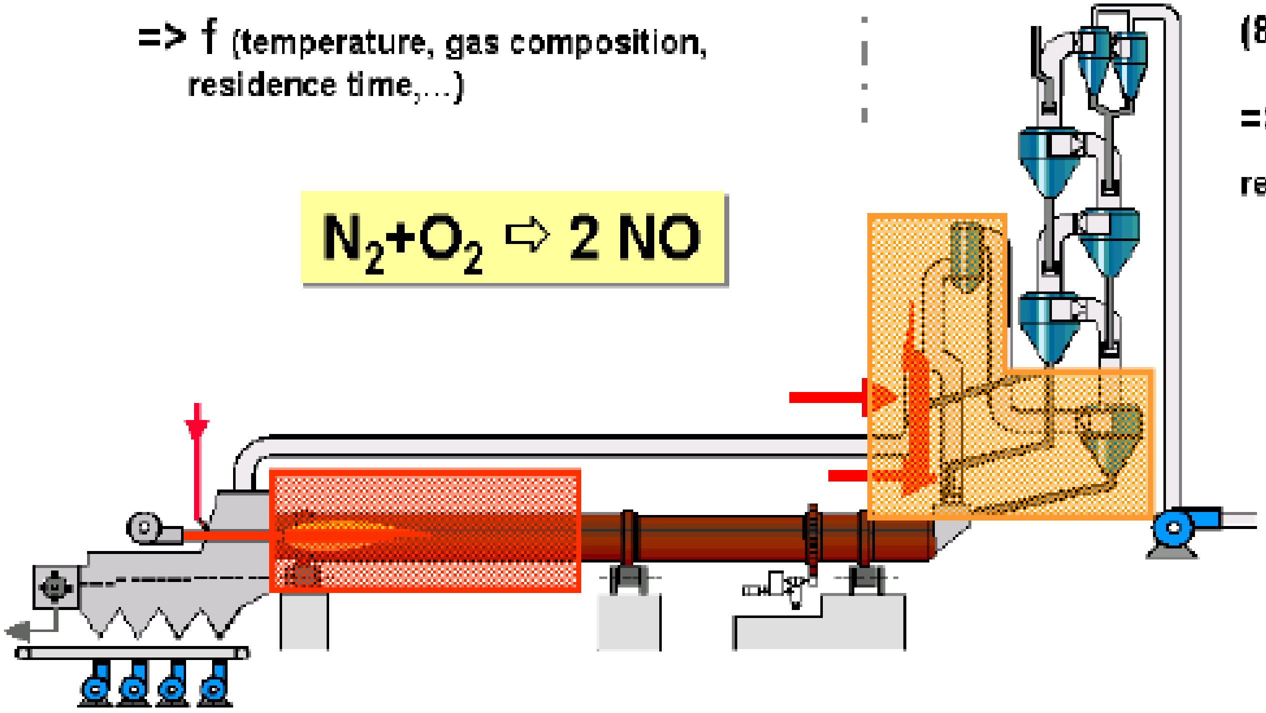
Fuel NOx

Raw material NOx

=> oxidation of N-fuel/RM

(800°<T°<1'200°C)

=> f (Nitrogen content, oxygen, residence time, % volatile,...)



Measures taken for NOx reduction

Sources and Reduction of NOx-Emissions:

There is no normal or average NOx emission from cement kilns. Many factors like kiln system, fuel characteristics and burning conditions are influencing the NOx emission.

The cement kiln NOx emissions vary largely between 300 and 2'500 mg /Nm3.

Our Strategy towards NOx reduction:

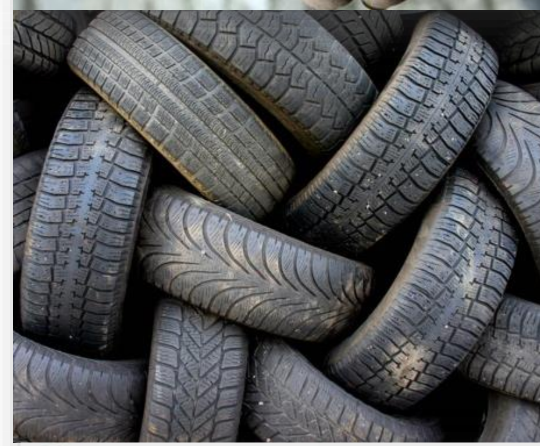
- Primary Measures:

  (Zero CAPEX and Low CAPEX projects)
  - Operation Optiomisation.
  - Low Nox calciner
  - Low Nox burner
  - Calciner Modification
  - Fuel Mix Optimisation
  - Calciner Mill curtain
- Secondary Measures:
  - SNCR
  - SCR

Note:
mg/NM3- mili gms/Normal cubic Meter

Sulphur input into the kiln system via fuel and raw materials

- Fuel
  - Coal: 0.5 - 4.0 % S
  - Fuel oil: 1.0 - 2.5 % S
  - Petcoke: 3.0 - 8.0 % S
  - Tires: 0.8 - 4.0 % S
- Raw material:
  - Variable from < 0.1 % to > 1 % S as SO_3
  - SO_3 average : ~ 0.45 % SO_3



General procedure for SOx abatement

Secondary measures – from dry to wet technology

- Dry methods
  - Addition of $Ca(OH)_2$, Na_2CO_3, activated coal, sponglacal lime (high specific surface)
  - Polvitec (activated coke filter)
- Semi-dry, Semi-wet methods
  - Injection of hydrated lime slurry (into the conditioning tower)
- Wet technologies
  - Wet scrubber

Precursors & primary measures

- Dry preheater kilns
  - Selective quarrying if possible, reduce high volatile S input
  - Increase mill running time
- Optimize combustion in case of long kilns!
  - Reduce S-input via fuels or raw material
  - Homogenize fuels (in case of SO_2 peaks)
  - Reduce sulfur volatility
    - Avoid combustion in reducing conditions , provide excess air (n
    - Avoid temperature peaks and over-burning (CaO_f 0.8-1.5%)
    - Avoid long flame, adjust burner momentum **(see example)**
    - Assure sulfatization of the alkalis
    - Burner position parallel to kiln axis
    - Optimum fuel fineness and dispersion
    - Stable kiln operation (Kiln Master)
    - Improve burnability of kiln feed by e.g. reducing the SM

Operation impact Alkali Issue:

Measures against Alkali Problems

♦ Alkali Volatility

In absence of sulfur the alkali volatility is very high and creates problems in the preheater. In such a case the raw mix can be sulfatizated by addition of gypsum.

♦ Low Alkali Clinker

If low alkali clinker must be produced, all measures must be taken to increase the alkali volatility, such as

∗ reducing the sulfur input

∗ producing a long and stable flame

∗ applying hard burning ($CaO_{free} < 1$), if possible reducing the burnability by increasing the silica ration

∗ applying a minimum of excess air

∗ chlorination of the raw mix either by burning chloride

∗ containing solvents or adding $CaCl_2$

♦ In case of long dry or wet kilns the alkalis are withdrawn by discarding a fraction or the total dust of the external cycle. In case of a SP kiln a (large) kiln gas bypass is required.

CONTROL PROCESSES

- What controls/check points are there?
- Process checklists..

Process Checklist –Cement industry

Ball Mill Standard Measurements

			Weekly	Monthly	Quarterly	Half- Yearly	Yearly
1	Circuit material granulometry						
2	Mill longitudinal sieving						
3	Ball charge filling degree						
4	Mill material level						
5	Mill ventilation						
6	Separator tromp curve						
7	Separator ventilation						
8	Mill internal conditioin						
9	Weigh feeder calibration						
10	Instrument verification						
11	Control loop verification						
12	Heat Balance where drying is important						
13	Grinding media sampling						
14	Grinding media regrading 1st Chamber						
15	Grinding media regrading 2nd Chamber						every two years
16	Cyclone/Bag house/Fan internal condition						

Please note - However above points exercise should be carried out whever required or after any modification

Process Checklist –Cement industry

Vertical Mill Standard Measurements

			Weekly	Monthly	Quarterly	Half Yearly	Yearly
1	Circuit material granulometry						■
2	Mill gas flow					■	
3	False air analysis			■			
4	Roller/Table liner profiles				■		
5	Mill internal conditioin			■			
6	Crash stop inspection				■		
7	Feed distribution on table					■	
8	Weigh feeder calibration					■	
9	Instrument verification						■
10	Control loop verification						■
11	Heat Balance						■
12	Cyclone/Bag house/Fan internal condition						■
13	Safety Interlocks for coal mill				■		

Please note - However above points exercise should be carried out whever required or after any modification

Process Checklist –Cement industry

Kiln Standard Measurements

		Weekly	Monthly	Quarterly	Half Yearly	Yearly
1	Heat & Mass balance					■
2	Combustion check			■		
3	Burner check			■		
4	Cooler air distribution			■		
5	False air investigation				■	
6	Temperature & Pressure profile in Pre-Heater				■	
7	Alk Sulfur Cl Balance					■
8	Instrument Check			■		
9	Calibration of feeders			■		
10	Dosing accuracy (Dust tools) for all feeders including fine coal,kiln feed,AF					■
11	Fuel Mix optimizer			■		
12	Gas analyser performance review		■			
13	AFR assessment (potential and debottleneck)					■
14	Monitoring of NOX/Sox and other emission, review and analysis					■

Please note - However above points exercise should be carried out whever required or after any modification

Cradle to Gate efficiency Saving -PAT cycle 1

Energy certificates in 2015 -16 Cycle

ENERGY SAVING

435 kCal
92354 mTOE

1% of ACL
Total primary energy consumption

Emission Reduction

8200 T CO_2 reduction

1.2% of ACL
Total emissions

Capacity Building

100+ Engineers and Operators

9+ Energy auditors & managers

Saving

938
Mio TOE

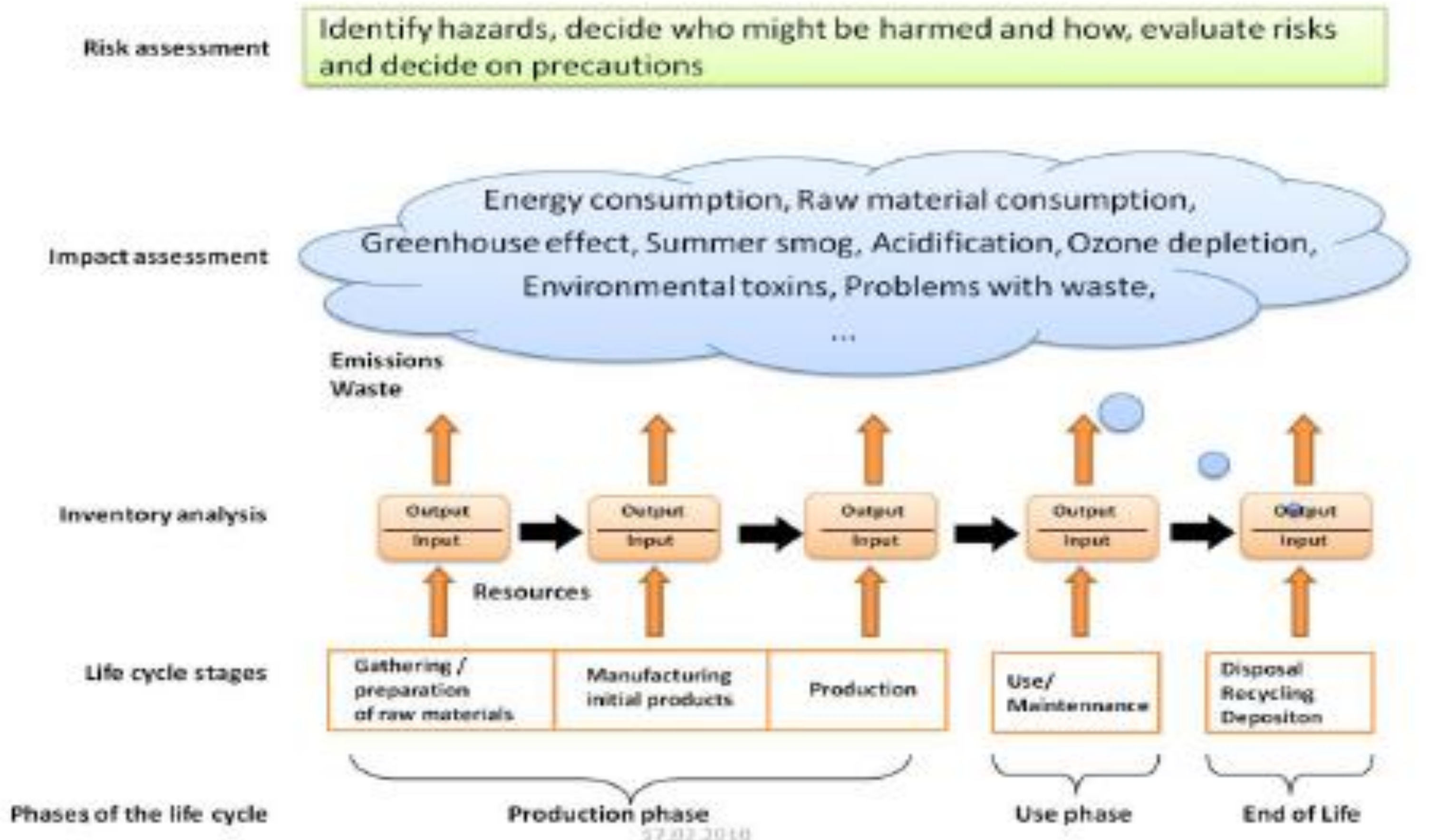
92355
Escert
(BANKED)

Note:
mTOE- million Tone Oil Equivalent

LCA study- Process Impact from Cement Manufacturing

- Life Cycle Assessment (LCA) is a relevant & key tool which helps in evaluating and assessing the environmental burdens during the life span of a product.
- Carry out a **Life Cycle Assessment (LCA) of Portland Pozzolana Cement Product at all plants of ACL.**
- As per ISO 14020:2000, IS0 14025:2006, ISO 14040:2006, EN 15804:2012 requirements as well as Cement PCR- UN CPC 3744:2013.
- GaBi Envision Software used for achieving multitude of benefits and value creation for the product, processes and supply chain.
- Environmental Product Declaration (EPD) is mainly intended for Business-to-Business (B2B) communication by bringing credible transparency and 3rd party assurance.
- **Ambuja Cements Ltd.** is **India's 1st cement company** to implement Environmental Product Declaration (EPD); an eco-labelling for the Portland Pozzolana Cement product.
- Companies like LafargeHolcim, Italcementi, CEMBUREAU, America Cement **Manufacturer's Association, UK Cement Industry (MPA)** also follow the practice.
- EPDs will soon become a mandatory requirement for business needs in India. Saint Gobain, JSW Steel are two companies in India who have published EPDs for gypsum board, architectural glass and structural steel.
- Developing and marketing EPDs prove to be a valuable practice to gain public recognition and increase customer loyalty.
- Provides instrumental information for optimizing resource consumption and improving processes for eco efficiency.

ISO 14040/44 as applied to the life cycle assessment



Scope & Inclusion of the study

- Cradle to Grave approach was observed:
  - Sourcing
  - Inbound transportation
  - Internal process
  - Outbound transportation
  - End use and disposal
- In line with Ambuja Sustainability Ambition 2020 and 2030, various scenarios are created:
  - Renewable energy mix
  - Increase in blending proportion
  - Increase in AFR
  - Energy reduction

Cradle to Gate Emissions Averaged from 5 IPs Cement Type-I Products

Pollutants Emitted from Cradle to Gate for 1 kg of Cement	
CO_2 (g/kg-cement)	750
SO_2 (g/kg-cement)	0.63
NO_X (g/kg-cement)	2.5
Dust (g-SPM/kg-cement)	1.5
Total Greenhouse Effect (g/kg-cement)	749[a]
Total Acidification (g/kg-cement)	2.4[b]
Total Eutrophication (g-PO_4/kg-cement)	0.33[c]
Total Winter Smog (g-SPM/kg-cement)	2.1[d]

For every 1 kg of cement produced, .75 kg of CO_2 is emitted.

Benefits

- Display Green Labels and Responsible Sourcing Schemes of the company.
- As a ‘sustainability passport’ for construction products, EPDs are a core element of green building certification

Ambuja Cement

1. Aim and Scope

Ambuja Cements Ltd, a part of the global conglomerate LafargeHolcim, is one of the leading cement companies in the Indian cement industry. This declaration aims to provide the effects measurable and verifiable for the environmental assessment of construction works done with one tonne Portland Pozzolana Cement manufactured at Ambuja Nagar clinker manufacturing unit and Ambuja Nagar grinding unit of Ambuja Cements Limited.

2. General information

2.1 EPD, PCR, LCA information

Table 1: EPD information

EPD information	
Program operator	The International EPD System Vasagatan 15-17 SE-111 20 Stockholm Sweden Email: info@environdec.com Web: www.environdec.com
Declaration holder[1]	Mr. Sandeep Shrivastava Ambuja Cements Limited 228, Udyog Vihar, Phase I, Gurgaon-122016 Email: sandeeps.shrivastava@ambujacement.com
Product	Portland Pozzolana Cement
Reference standards	IS0 14020:2000, ISO 14025:2006, ISO 21930:2007

Table 2: PCR information

Reference PCR	UN CPC 3744 (Cement) 2010-09-15, PCR 2010:09
Date of Issue	2013-05-16
Period of Validity	2018-05-16

Table 3: LCA information

LCA information	
Title	LIFE CYCLE ASSESSMENT REPORT – 2016 Portland Pozzolana Cement Ambuja Cements Limited
Preparer	Dr. Rajesh Kumar Singh Thinkstep Sustainability Solutions Pvt. Ltd. 421, MIDAS, Sahar Plaza, Andheri Kurla Road, Andheri East, Mumbai, India – 400059 Email: Rajesh.Singh@thinkstep.com
Reference standards	ISO 14040/44 standard

2.2 Reference period of EPD data
The reference period for the data used within this EPD is the year 2016.

2.3 Geographical scope of EPD application
The geographical scope of this EPD is India.

[1] This declaration has not been externally verified and registered with the Program Operator. This is a self-declared EPD by Ambuja Cements Limited

Ambuja Cement

standards, and is suggested to be feasible only if all compared declarations follow equal standard provisions.

4.7 Results

Table 9: LCIA Result for 1000 kg average cement

LCIA Impact Category	Unit	Module A1- A3
Abiotic Depletion (ADP elements)	kg Sb-Eq.	8.52E-04
Abiotic Depletion (ADP Fossil)	MJ	3610
Acidification Potential	kg SO2-Eq.	1.310
Eutrophication Potential	kg Phosphate-Eq.	0.244
Global Warming Potential, excl biogenic carbon	kg CO_2-Eq.	807
Ozone Layer Depletion Potential	kg R11-Eq.	2.55E-10
Photochemical Ozone Creation Potential	kg Ethene-Eq.	0.099

Table 10: Use of Natural Resources for 1000 kg average cement

Parameters	Unit	Module A1- A3
Renewable primary energy as energy carrier	MJ	20.5
Renewable primary energy resources as raw materials	MJ	0
Total renewable primary energy resources (primary energy and primary energy resources as raw materials)	MJ	20.5
Non- renewable primary energy as energy carrier	MJ	3630
Non- renewable primary energy resources as raw materials	MJ	0
Total non- renewable primary energy resources (primary energy and primary energy resources as raw materials)	MJ	3630
Use of secondary material	kg	308.20
Use of renewable secondary fuels	MJ	13.00
Use of non- renewable secondary fuels	MJ	219.72
Use of net fresh water	m^3	0.122

Table 11: Other Indicators for 1000 kg average cement

Parameters	Unit	Module A1-A3
Components for reuse	kg	0
Materials for recycling	Kg	0
Exported energy	MJ	0
Dust: PM10-equivalents	kg	0.055

Table 12: Supplementary Indicators for 1000 kg average cement

Parameters	Unit	Module A1-A3
Non-hazardous waste	kg	
Hazardous waste	kg	
Radioactive waste	kg	0.001

EPD of Ambujanagar

Sample EPD For One Of The Plants

LCIA Result for 1000 kg average cement

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Supplementary indicators for 1000 kg average cement

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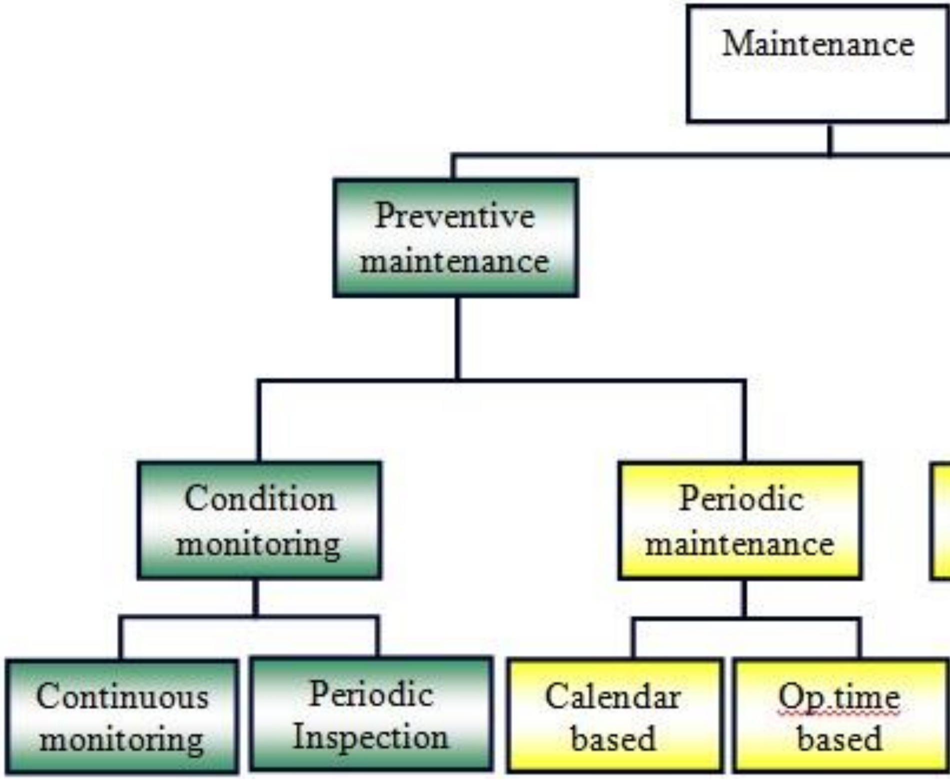
Non-hazardous waste	kg	
Hazardous waste	kg	
Radioactive waste	kg	0.001

EQUIPMENT & FACILITIES

- Equipment Maintenance Strategies
- Condition Based Monitoring

Plant Maintenance- CBM followed in Manufacturing Units

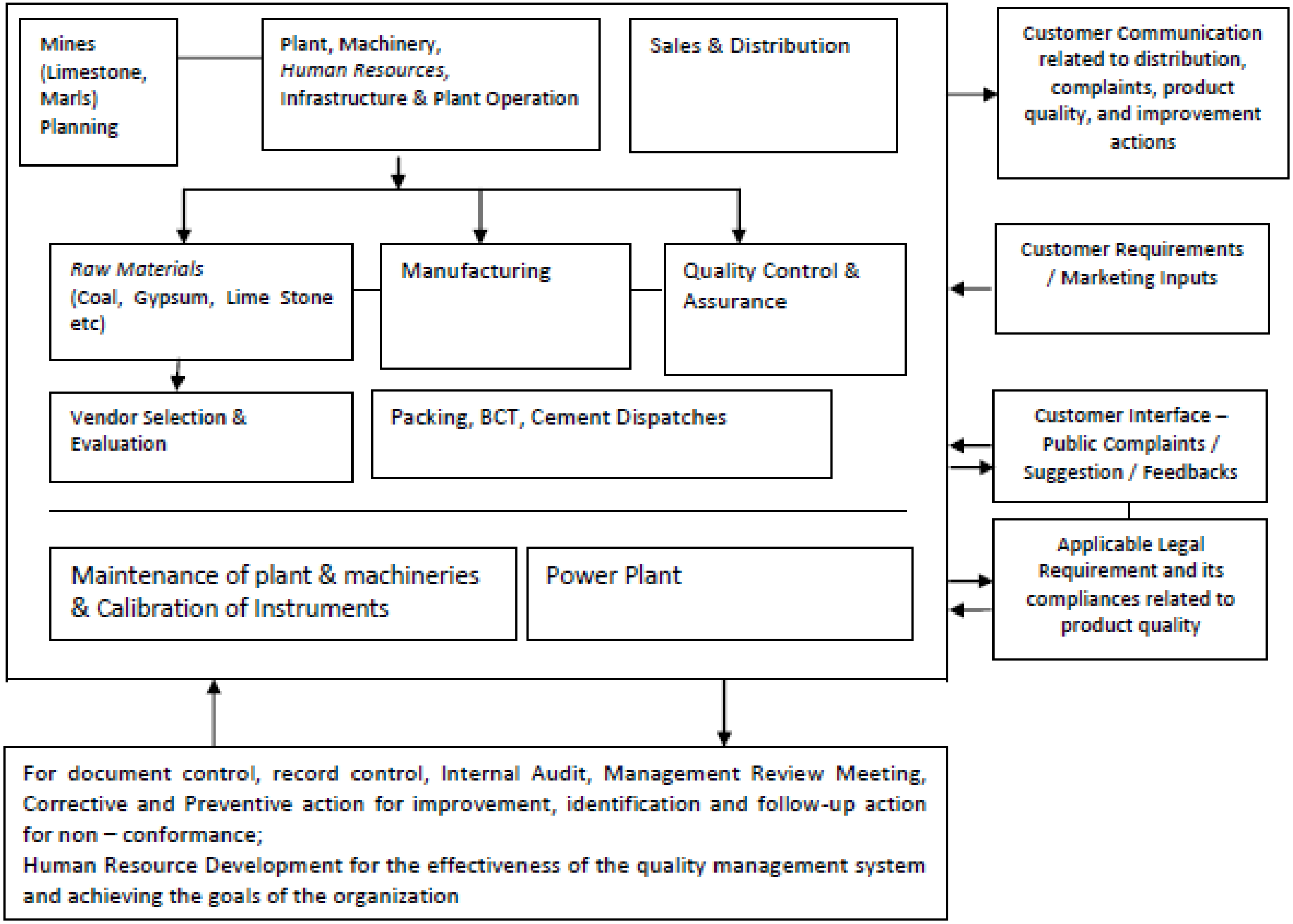


Condition based maintenance (CBM) is a maintenance strategy that monitors the actual **condition** of the asset to decide what maintenance needs to be done. CBM dictates that maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure

SUPPORT PROCESSES

- Connections with other processes.
- Interactions with other processes

Support Process Flow Diagram



PERSONNEL

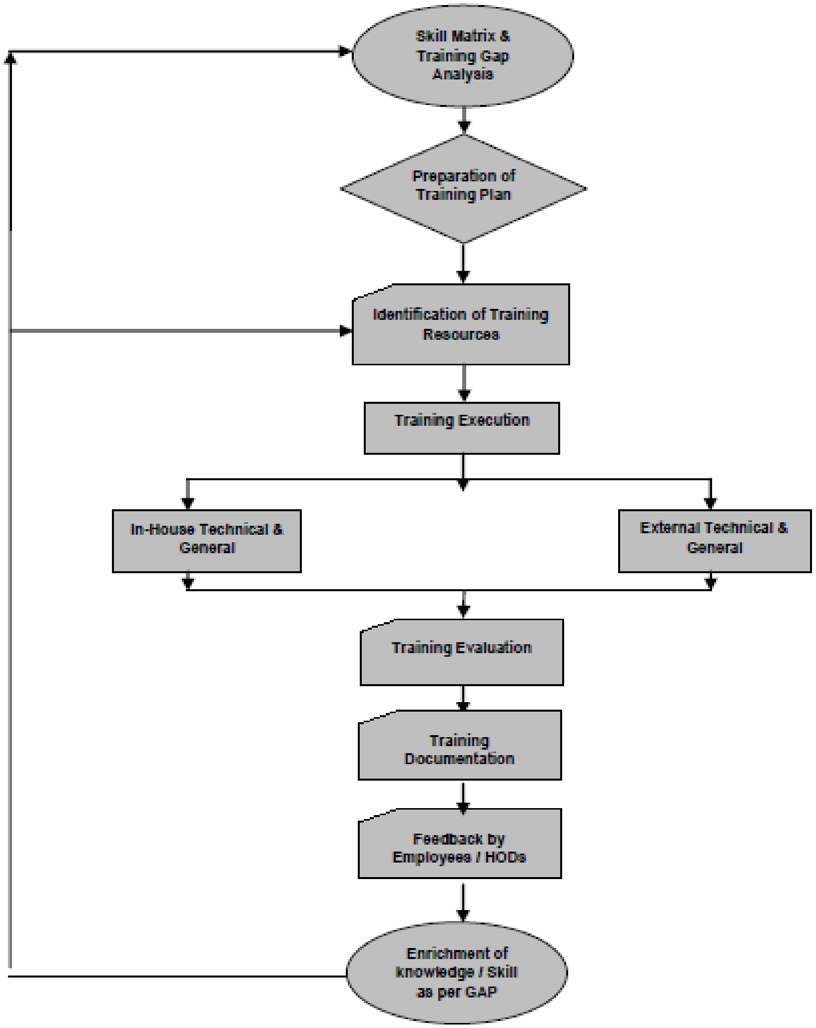
- Review employee skill lists for the process.
- Skill Matrix in Ambuja

Skill Development- RESOURCE MANAGEMENT

Training needs of employees are identified based on the skill gaps for performance of their responsibilities as identified in the Skill Matrix.

Training calendar shall be prepared by the **AALA**, with the consultation of concerned Department. Certain training shall also be identified by Corporate HR Department.

Training may be carried out **in lecture style, hands on experience training, coaching & mentoring**, workshops and on-the-jobs. The nature and medium of training of employees shall be dependent on the complexity of work and educational / language skills of employee. Training is organized as per the Training calendar. **Effectiveness of functional training** for work affecting product quality / having significant environmental aspect / impact and Hazard Risk **Assessment** is evaluated by the concerned superior within 3 months of the training. Refresher training as per the result of evaluation of training effectiveness is organized. Record of Training and effectiveness evaluation is maintained.



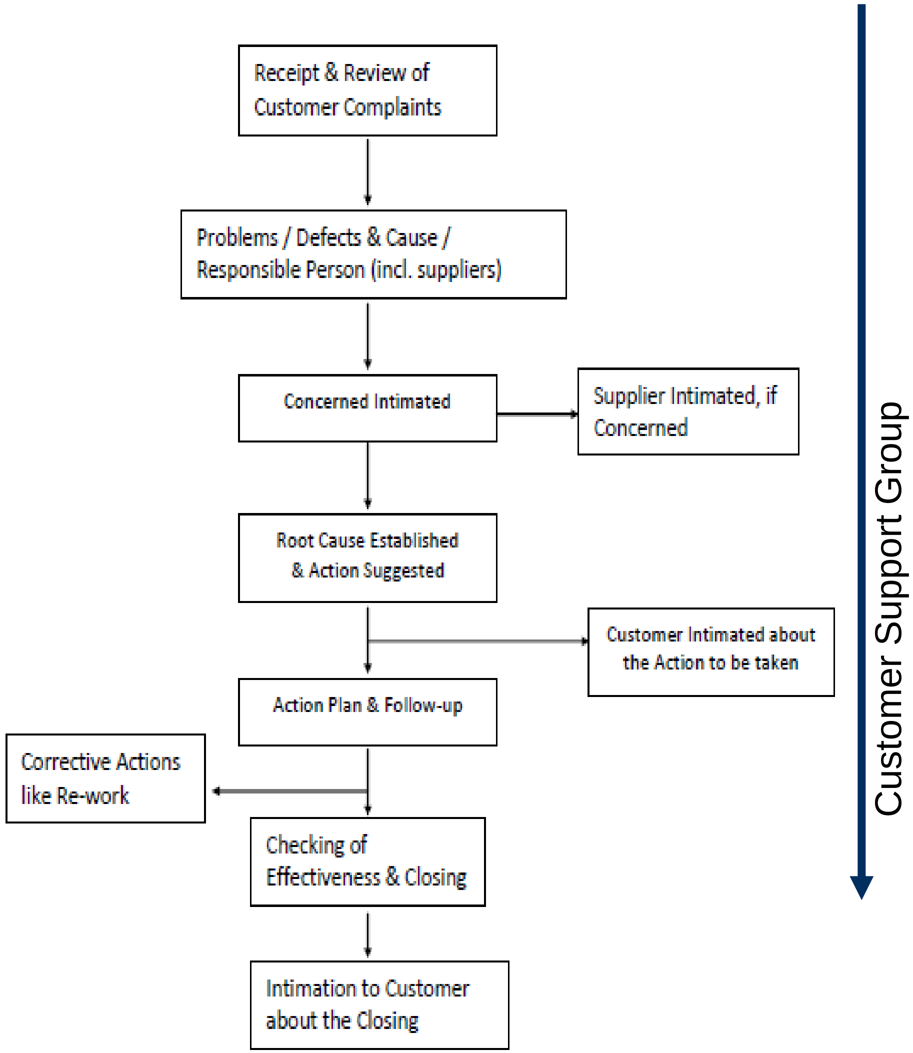
CONTROL PROCESSES

- How is the process defined and who is responsible?
- Customer requirements defined?
- Customer Complain flow in Central Office

Flow Chart for Handling of Customer Complaints Process

Reviewing non-conformances i.e. Customer complaints

- Results of Internal audits (
- Performance tracking reports (MIS team, KPI monitoring)
- Review of implementation of Management Programs
- Monitoring of key characteristics of operations
- Evaluation of compliance against legal and other requirements
- Communication from External interested parties



Ambuja Cement

Strength. Performance. Passion.

Thanks…!!