CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
Version 02 - in effect as of: 1 July 2004)

CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

Mysore Cements Limited Portland Slag Cement project
Version 3
Date-25/09/2006

A.2. Description of the project activity:

Background

Mysore Cements Limited (MCL), one of the leading companies of S. K. Birla Group was promoted in 1958. The company has three units located at Ammasandra in Karnataka, Damoh in Madhya Pradesh and Jhansi in Uttar Pradesh. Its first unit was established at Ammasandra in 1962. The plant manufactures Ordinary Portland Cement (OPC) and Portland Slag Cement (PSC). PSC is manufactured as per IS-455/1989 by intergrinding clinker, gypsum and granulated slag in suitable proportion and marketed under the brand name Birla Power and Diamond Super. Slag is added to convert liberated calcium hydroxide during curing of OPC to form strength giving compound to yield higher long-term strength and durability.

Purpose

The purpose of the project activity is to increase the share of slag in the Portland Slag Cement (PSC) production at Mysore Cements Limited (MCL). This reduces clinker use in the PSC production, thus reduces associated greenhouse gas (GHG) effect with clinker production, lowering CO_2 emissions per ton of cement production.

Manufacturing of clinker consists of grinding and pyro processing of raw materials. The reduction in clinker percentage in the blended cement results in conservation of limestone. This displaces calcinations of certain amount of limestone used for clinker production and its associated greenhouse gas (GHGs) emissions into the atmosphere. This also reduces thermal and electrical energy used in the production of clinker and its associated indirect GHGs emissions.

The plant is having complete cement manufacturing process like clinker production, mixing and grinding of slag /gypsum to produce blended cement. The main raw material limestone for clinker production is sourced from quarry situated at about 16km by road. The stone is transported to the factory by Aerial Rope way. The slag is procured from outside parties, which is a by-product from the iron making process.

Contribution of the project activity to sustainable development

Ministry of Environment and Forests, Govt. of India has stipulated the social well being, economic well being, environmental well being and technological well being as the four indicators for sustainable development in the approval guidelines for CDM projects.

Social well being

The project activity has resulted in direct and indirect employment generation due to transportation of slag from the steel plant to the project site. The reduction in clinker production has also reduced the energy demand for clinker production. The equivalent amount of power can be used in other activity and reduces overall electricity demand in the region by certain amount.

Setting times of concretes containing slag increases as the slag content increases. An increase of slag content from 35 to 65% by mass can extend the setting time by as much as 60 minutes. This delay can be beneficial, particularly in large pours and in hot weather conditions in which this property prevents the formation of "cold joints" in successive pours. It has got superb resistance to Sulphate and chloride and hence specially suitable and highly advantageous for construction in coastal areas as it contains slag and lower C_3A content. It also gives higher long term and strength and durability to the concretes.

Economic well being

Reduction in clinker production conserves energy. This improves the power availability in the region and assists overall economic development of the region. Due to lower heat of hydration of PSC as it contains slag, it is most suitable for mass concreting works like dams, bridges etc. so that the thermal cracking is reduced. This creates saving for contractors, builders etc.

Environmental well being

Granulated slag, is a by-product from iron making process. In the absence of the project activity, the slag would have been dumped in designated landfill sites and the cement would have been manufactured from the traditional clinker and gypsum. Reduction in clinker percentage reduces the demand for limestone consumption, which further reduces the demand for quarry mining. This reduces GHGs emissions into the atmosphere associated with the production of clinker. It also reduces specific energy consumption for cement production. The reduction in electricity consumption for clinker production reduces a certain amount of electricity demand, thus displacing fossil fuel use for equivalent amount of electricity generation.

Technological well being

The project activity involves implementation of a newly built infrastructure using state of the art technology. The increased percentage of slag additives PSC has got superb resistance to environmental attacks, chemical attacks, lower expansion and lower permeability and hence best suited and very advantageous for construction in coastal areas, factory buildings, residence, schools , dams etc.

A.3. Project participants:

Name of Party involved (*) ((host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
India(Host)	Mysore Cements Limited	No

A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

Ammsandra, Taluka: Turvekre, District: Tumkur, State: Karnataka

A.4.1.1. Host Party(ies):

Government of India

A.4.1.2. Region/State/Province etc.:

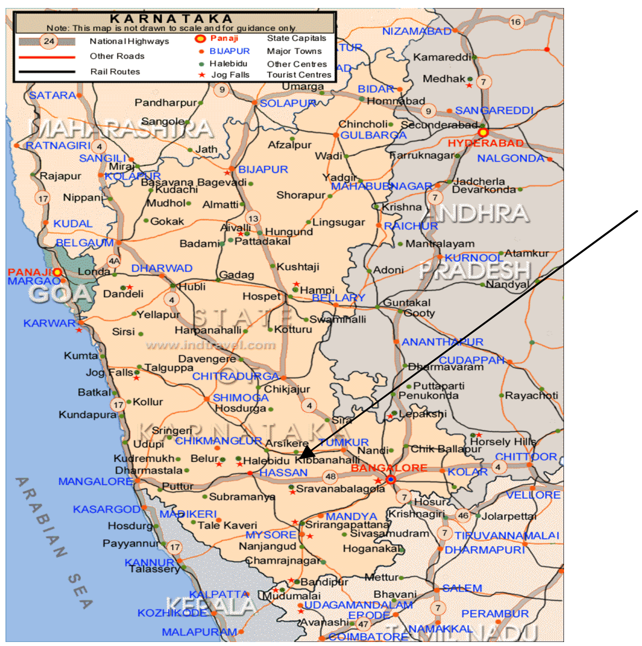
State – Karnataka

A.4.1.3. City/Town/Community etc:

Ammasandra, District – Tumkur

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):

The existing "slag & clinker grinding and mixing unit" is located at Ammsandra, Taluka: Turvekre, District Tumkur, state: Karnataka, India. It is geographically located at 76° 44'E latitude and 12° 24'N longitude. The site is at a distance of 46 km from Tumkur, 125 km from Bangalore by road. The nearest railway station is at Ammasandra, while Nearest airport / airstrip – Bangalore.



A.4.2. Category(ies) of project activity:

>> The project activity is a cement sector specific project activity. The project activity is categorized in Category 4: Manufacturing Industries.

A.4.3. Technology to be employed by the project activity:

The project activity used existing blending set up. It intended to increase slag percentage in the PSC with similar characteristics as the baseline PSC. As a consequence, this project component is supported by additional efforts including additional equipment installations and replacement, research and

development (R&D) on slag content and quality, marketing and promotional activities in the market. MCL's Research and Development Department has developed the technology indigenously, that increases the slag share in PSC. MCL in their Research and Development had conducted numerous trials and experiment with varying percentage of slag addition and varying clinker qualities. The Research & Development Department had ascertained the quality of different type of PSC produced and marketing department verified the response from the market.
Additional equipment installed / replaced/modified:

- Facilities for storage, handling and proportioning of additive materials such as additional hoppers/storage, feeders, conveyors and cement grinding aid.
- Additional and modified liners both in terms of shape and metallurgy.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

The project activity consists of increasing the slag share in PSC produced at MCL. This reduces clinker production and associated GHG emissions. This also reduces thermal and electrical energy used in the production of clinker. Production of PSC in India is subject to the Bureau of Indian Standards specification IS: 455: 1989. This states that the slag constituent shall be not less than 25% nor more than 65% of the Portland Slag cement. The project activity always meets the above BIS requirements. Therefore there was no incentive to increase the percentage of slag in the PSC.

In the absence of the project activity, the increased amount of slag would have been dumped in designated landfill sites and the cement would have been manufactured with the existing practice of PSC production. Thus the project activity reduces clinker percentage in the PSC and associated CO_2 emissions from the calcinations of limestone in kilns.

The proposed project activity increases the slag share in the PSC that is not a common practice in the region. It faces certain barriers and requires efforts to cross all those barriers. At the market place OPC is perceived as a stronger cement type in comparison to PSC. The increasing percentage of slag further creates an adverse impact on customer about the strength of the produced PSC. There are a number of government departments, which still bring out tenders requiring only OPC for major construction projects where blended cement would have meet the requirements.

This requires marketing and educational effort to counter the negative impact among the customer; and aware them about the increasing percentage and its impact on strength of the PSC. The R&D department and marketing department has made considerable effort to enable the increase in slag blending associated with the cement production, whilst maintaining the quality of the PSC. The management has also undertaken extra effort in promotion activities.

In the absence of the project activity, these actions would not have otherwise happened, and the slag used in the PSC would remain at the baseline level. Thus clinker production and associated emissions from the cement production would be higher than the project activity.

The estimated total reduction in tones of CO_2 equivalent over the crediting period of 10 years is 3,58,064 tCO_2e for the first crediting period

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

Year	Annual estimation of emission reductions in tonnes of CO_2e
2001	13168
2002	35129
2003	31880
2004	30804
2005	31722
2006	32514
2007	40785
2008	45316
2009	46107
2010	50639
Total estimated reductions (tonnes of CO_2e)	358064
Total number of crediting years	10
Annual average over the crediting period of estimated reductions(tonnes of CO_2e)	35806

A.4.5. Public funding of the project activity:

>> No public funding or official development assistant (ODA) has been used on this project activity.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

Title: Consolidated Baseline Methodology for Increasing the Blend in Cement Production
Reference: Approved consolidated baseline methodology ACM0005 / Version 03, Sectoral Scope: 4, 19 May 2006

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

>>

This methodology is applicable to projects that increase the share of additives (i.e. reduce the share of clinker) in the production of cement types beyond current practices in the country. Additives are defined as materials blended with clinker to produce blended cement types and include fly ash, gypsum, slag, etc.	The project activity reduces the share of clinkers in the production of cement, which is beyond the current practices in the country.
There is no shortage of additives related to the lack of blending materials. Project participants should demonstrate that there is no alternative allocation	The project activity involves production of Portland slag cement from granulated slag, which is a by-product from iron making units of Corex &

or use for the additional amount of additives used in the project activity. If the surplus availability of additives is not substantiated the project emissions reductions (ERs) will be discounted as outlined below.	Mysore Cement sources slag from JSW Steel Ltd which is one of the big plant in the state of Karnataka. It also sources slag from Visvesvarya Iron and Steel Limited and Kalyani Steels Ltd. JSW Steel installed capacity during the year 1999-2000 was 0.8 MTPA and currently the installed capacity is 3.8 MTPA. It is expected to increase steel production to nine million tonnes by 2009-10. Other players like South West Iron Steel Ltd, Kiloskar Ferrous Industries Ltd, Ispat Industries Ltd, Surana Industries Ltd and BMM Ispat Ltd are executing major projects in the region. During the last three years 100 sponge iron plants were also sanctioned in the region. JSW Steel Ltd source states that “for each tonne of steel produced in the steel manufacturing process about 350 kg of slag and 400 kg of granulated slag are produced.” The region defined in the PDD produced 0.7 million tonnes of slag cement during the year 1999-2000 and currently it produces 3.7 Million tonnes of slag cement. As a conservative estimation this requires 2 million tonnes of slag (50-60 % slag) for the production of 3.7 million tonnes of slag cement. JSW Steel only produces slag ranges between 1.2 - 1.4 Million tonnes. Order bordering states to Karnataka are also having Steel Manufacturing units that produce slag from its production process. In 2005, about 30 million tonnes of iron ore was extracted from the Bellary-Raichur-Koppal (Karnataka state) triangle making it one of the key producers of high grade iron ore.[1] (To produce one tonne of virgin steel 1500kg of iron ore is required). This gives an estimated production of 20 million tonnes of Steel from the iron ore. The same amount of steel manufactured would produce 7 to 8 million tonnes of slag. This justifies that the slag produced in the steel plant is available for other use and in the absence of the project activity, the slag would be dumped in designated landfill sites. So there is no shortage of blending material there is also no alternative allocation or use for the additional amount of additives used in the project activity.

[1] Steel majors flock Karnataka with Rs 30,600 crore plans, Business standard, dt 25/09/2006.

This methodology is applicable to domestically sold output of the project activity plant and excludes export of blended cement.	The cement produced is sold in the domestic market.
Adequate data are available on cement types in the market.	The data is available from Cement Manufacturers Association (CMA), India.

Above argument justifies the choice of ACM 0005 for the project activity and the applicability conditions.

B.2. Description of how the methodology is applied in the context of the project activity:

The methodology ACM0005 is applied in the following steps:

Identification of baseline scenario

A possible set of alternative is drawn up which will be there in the absence of the CDM activity.
Alternative (a): The project activity without the CDM revenue
Alternative (b): Continue with existing practice of PSC production
Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances.

The tool for demonstration of additionality is used to determine the most likely baseline scenario (see Section B.3.).

Additionality

It is discussed in B.3

Baseline Emissions

The benchmark for baseline emissions is defined as the lowest value among the following:
(i) The average (weighted by production) mass percentage of clinker for the 5 highest blend cement brands for the relevant cement type in the region; or
(ii) The production weighted average mass percentage of clinker in the top 20% (in terms of share of additives) of the total production of the blended cement type in the region; or
(iii) The mass percentage of clinker in the relevant cement type produced in the proposed project activity plant before the implementation of the CDM project activity.
The first step is to define the relevant region for each project. As outlined in the methodology:

Selecting region

As per the methodology ACM0005 the "Region" for the benchmark calculation needs to be clearly determined and justified by project participants. The default selection is the national market but PPs can define a geographic region as the area where each of the following conditions are met: (i) at least 75% of project activity plant's cement production is sold (percentage of domestic sales only); (ii) includes at least 5 other plants with the required published data; and (iii) the production in the region is at least four times the project activity plant's output. Only domestically sold output is considered and any export of cement produced by the project activity plant are excluded in the estimation of emission reductions.

Geographic region wise considering India as the default national market is not appropriate due to larger size of domestic market and regional disparity in cement market within the country. The increased slag used in the cement production undertaken in different parts of India varies widely. Thus the region is limited to the geographic extent of the states where the party caters their cement production.
As per the "Cement Statistic 2000", CMA the Indian Cement plants are classified as follows:
5 regions wise: Northern Region, Western Region, Eastern Region, Southern Region, Central Region.

7 cluster wise: Chanderia, Satna, Bilaspur, Chandrapur, Gulbarga, Nalgonda and Yerranguntla
State wise: states and union territories

MCL is located in the state of Karnataka. The plant caters their cement to Karnataka state and adjoining state market and cement clusters. The key parameters affecting the percentage of additive blending vary widely in cement manufacturing units across India depending on the local scenarios. Therefore, the region is defined as: Karnataka, Kerala, Pondicherry, Tamil Nadu, Maharashtra, Goa and Gulbarga cluster, Yerraguntla cluster, Nalgonda Cluster, Chandrapur Cluster.

Geographic region as the area where each of the following conditions are met: (i) at least 75% of project activity plant's cement production is sold (percentage of domestic sales only); (ii) includes at least 5 other plants with the required published data; and (iii) the production in the region is at least four times the project activity plant's output.

Cement manufactured by MCL is supplied to different states as follows:

Base year 1999-2000		
State	**Quantity (tones)**	**Percentage (%)**
Karnataka	333458.679	74.7197
Kerala	101442.00	22.7306
Pondicherry	6429.00	1.440577
Other state and clusters	4949.8	1.109126
Total	446279.479	

The above table establishes that the PPs mostly sold their cement to Karnataka and Kerala (97.5%) state. Therefore the region meet the first conditions: (i) at least 75% of project activity plant's cement production is sold (percentage of domestic sales only).

Plants under the region		
Sr Number	Plant name	State/clusters
1	Chettinad Cement	Tamil Nadu
2	Indo Rama Cement	Maharashtra
3	Priyadarshini	Nalgonda Clusters
4	Kanoria Industries	Karnataka
5	Dalmia Cements	Tamil Nadu

The above table demonstrates that the region includes 5 other cement plants (plants manufactured Portland Slag cement during 1999-2000) with the required published data. Therefore, the region criteria fulfils the second condition (ii) includes at least 5 other plants with the required published data.

and

The production in the region is more than four times the project activity plant's output. The cement production in the region is 34799.34 (000 tonnes) during the year 1999-2000. It is 79 times the production of the project proponent. Therefore the region criteria fulfil the third condition (iii) the production in the region is at least four times the project activity plant's output.

As per the methodology ACM 0005, only domestically sold output is considered and any export of cement produced by the project activity plant are excluded in the estimation of emission reductions.

Benchmark of Baseline Emissions

The benchmark for baseline emissions is defined as the lowest value among the following:

(i) The average (weighted by production) mass percentage of clinker for the 5 highest blend cement brands for the relevant cement type in the region; or

In the region only five parties were selling the PSC in the market. The average (weighetd by production) mass percentage of clinker for the PSC is 61.69%.

(ii) The production weighted average mass percentage of clinker in the top 20% (in terms of share of additives) of the total production of the blended cement type in the region; or

The production weighted average mass percentage of clinker in the top 20% of the total production of the blended cement type in the region is 66.58%.

(iii) The mass percentage of clinker in the relevant cement type produced in the proposed project activity plant before the implementation of the CDM project activity.

The mass percentage of clinker in the relevant cement type produced in the proposed project activity plant before the implementation of the CDM project activity is 71.56 %. The highest percentage of additives used over the 3 most recent years is selected.

Selected benchmark baseline for clinker (1999-2000) base year		
i	ii	iii
61.69%	66.58%	71.56%
Selected benchmark baseline for additives (1999-2000) base year		
√		
39.31%	33.42%	29.44%

The methodology stipulates that the lowest value among the three options be selected as the benchmark baseline for the base year (1999-2000). So option (i) is the benchmark baseline.

This reduces the list of plausible alternative to Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances. (In the region only five other manufacturing plants were producing PSC in the market. The average mass percentage of clinker for the PSC is 61.69 %.)

Trend increase in additive blend

As outlined in the ACM 0005, the benchmark incorporates a trend increase, specified ex-ante, in the share of additives in blended cement type based on a minimum of an annual 2% increase in additives.

Baseline Emissions

$$\mathbf{BE_{BC,y} = [BE_{clinker} * B_{Blend,y}] + BE_{ele\_ADD\_BC}}$$

where:

$BE_{BC,y}$ = Baseline CO_2 emissions per tonne of blended cement type (BC) (t CO_2/tonne BC)

$BE_{clinker}$ = CO_2 emissions per tonne of clinker in the baseline in the project activity plant (t CO_2/tonne clinker) and defined below

$B_{Blend,y}$ = Baseline benchmark of share of clinker per tonne of BC updated for year y (tonne of clinker/tonne of BC)
$BE_{ele\_ADD\_BC}$ = Baseline electricity emissions for BC grinding and preparation of additives (tCO_2/tonne of BC)
CO_2 per tonne of clinker in the project activity plant in the baseline is calculated as below:

$$\mathbf{BE_{clinker} = BE_{calcin} + BE_{fossil\_fuel} + BE_{ele\_grid\_CLNK} + BE_{ele\_sg\_CLNK}}$$

where:
$BE_{clinke}r$ = Baseline emissions of CO_2 per tonne of clinker in the project activity plant (t CO_2/tonne clinker)
BE_{calcin} = Baseline emissions per tonne of clinker due to calcinations of calcium carbonate and magnesium carbonate (t CO_2/tonne clinker)
BE_{fossil_fuel} = Baseline emissions per tonne of clinker due to combustion of fossil fuels for clinker production (t CO_2/tonne clinker)
$BE_{ele\_grid\_CLNK}$ = Baseline grid electricity emissions for clinker production per tonne of clinker (t CO_2/tonne clinker)
$BE_{ele\_sg\_CLNK}$ = Baseline emissions from self generated electricity for clinker production per tonne of clinker (t CO_2/tonne clinker)

$$\mathbf{BE_{calcin} = [0.785*(OutCaO - InCaO) + 1.092*(OutMgO - InMgO)] / [CLNK_{BSL} * 1000]}$$

where:
BE_{calcin} = Emissions from the calcinations of limestone (tCO2/tonne clinker)
0.785 = Stoichiometric emission factor for CaO (tCO2/t CaO)
1.092 = Stoichiometric emission factor for MgO (tCO2/t MgO)
InCaO = CaO content (%) of the raw material * raw material quantity (tonnes)
OutCaO = CaO content (%) of the clinker * clinker produced (tonnes)
InMgO = MgO content (%) of the raw material * raw material quantity (tonnes)
OutMgO = MgO content (%) of the clinker * clinker produced (tonnes)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilo tonnes of clinker)

$$\mathbf{BE_{fossil\_fuel} = [\sum FF_{i\_BSL} * EFFi] /[CLNK_{BSL} * 1000]}$$

FF_{i_BSL} = Fossil fuel of type i consumed for clinker production in the baseline (tones of fuel i)
EFF_i = Emission factor for fossil fuel i (t CO2/tonne of fuel)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilo tonnes of clinker)

$$\mathbf{BE_{ele\_grid\_CLNK} = [BELE_{grid\_CLNK} * EF_{grid\_BSL}] /CLNK_{BSL} * 1000}$$

$BELE_{grid\_CLNK}$ = Baseline grid electricity for clinker production (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilo tonnes of clinker)

$$\mathbf{BE_{elec\_sg\_CLNK} = [BELE_{sg\_CLNK} * EFs_{g\_BSL}] /[CLNK_{BSL} * 1000]}$$

$BELE_{sg\_CLNK}$ = Baseline self generation of electricity for clinker production (MWh)
$EFsg\_{}_{BSL}$ = Baseline electricity self generation emission factor (t CO_2/MWh)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilo tonnes of clinker)

$$\mathbf{BE_{ele\_ADD\_BC} = BE_{ele\_grid\_BC} + BE_{ele\_sg\_BC} + BE_{ele\_grid\_ADD} + BE_{ele\_sg\_ADD}}$$

where:
$BE_{ele\_grid\_BC}$ = Baseline grid electricity emissions for BC grinding (tCO_2/tonne of BC)
$BE_{ele\_sg\_BC}$ = Baseline self generated electricity emissions for BC grinding (tCO_2/tonne of BC)

$BE_{ele\_grid\_ADD}$ = Baseline grid electricity emissions for additive preparation (tCO_2/tonne of BC)
$BE_{ele\_sg\_ADD}$ = Baseline self generated electricity emissions for additive preparation (tCO_2/tonne of BC)

$$\mathbf{BE_{ele\_grid\_BC} = [\ BELE_{grid\_BC} * EF_{grid\_BSL}] / [BC_{BSL} * 1000]}$$

$BELE_{grid\_BC}$ = Baseline grid electricity for grinding BC (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilo tonnes of BC)

$$\mathbf{BE_{elec\_sg\_BC} = [BELE_{sg\_BC} * EF_{sg\_BSL}] / [BC_{BSL} * 1000]}$$

$BELE_{sg\_BC}$ = Baseline self generation electricity for grinding BC (MWh)
EF_{sg_BSL} = Baseline electricity self generation emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilo tonnes of BC)

$$\mathbf{BE_{ele\_grid\_ADD} = [\ BELE_{grid\_ADD} * EF_{grid\_BSL}] / [BC_{BSL} * 1000]}$$

$BELE_{grid\_ADD}$ = Baseline grid electricity for grinding additives (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
ADD_{BSL} = Annual consumption of additives in the base year (kilo tonnes of additives)
The factor (**$BE_{ele\_grid\_ADD}$**) is zero because slag is grinded with clinker in the ball mill.

$$\mathbf{BE_{elec\_sg\_ADD} = [BELE_{sg\_ADD} * EFsg\_BSL] / [BC_{BSL} * 1000]}$$

$BELE_{sg\_BC}$ = Baseline self generation electricity for grinding additives (MWh)
EF_{sg_BSL} = Baseline electricity self generation emission factor (t CO_2/MWh)
ADD_{BSL} = Annual consumption of additives in the base year (kilo tonnes of additives)

The factor (**$BE_{elec\_sg\_ADD}$**) is zero because slag is grinded with clinker in the ball mill.

For the calculation of the specific emissions from power generation from the grid (EF_{grid_BSL} or $_y$) the approved consolidated baseline methodology ACM0002 is applied. The Southern regional grid is considered as the grid, which is supplying electricity to the project activity.

Justification for Southern grid: In India, power is a concurrent subject between the state and the central governments. The perspective planning, monitoring of implementation of power projects is the responsibility of Ministry of Power, Government of India. At the state level the state utilities or state electricity boards (SEBs) are responsible for supply, transmission, and distribution of power. With power sector reforms there have been unbundling and privatisation of this sector in many states. Many of the state utilities are engaged in power generation also. In addition to this there are different central / public sector organizations involved in generation like National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC), etc. in transmission e.g. Power Grid Corporation of India Ltd. (PGCIL) and in financing e.g. Power Finance Corporation Ltd. (PFC). There are five regional grids: Northern, Western, Southern, Eastern and North Eastern. Different states are connected to one of the five regional grids as shown in the below table.

Northern	Western	Southern	Eastern	North Eastern
Haryana	Gujurat	AP	Bihar	Assam
HP	MP	Karnataka	Jharkhand	Manipur
JK	Chhattisgarh	Kerala	Orissa	Meghalaya
Rajasthan	Maharashtra	TN	WB	Nagaland
UP	Goa	Lakshadweep	D.V.C	Tripura
Uttarnanchal	D.N.H	Pondicherry	A&N	Arunachal Pradesh
Chandigarh	Daman& Diu		Sikkim	Mizoram
Delhi				

The management of generation and supply of power within the regional grid is undertaken by the load dispatch centres (LDC). Different states within the regional grids meet the demand from their own generation facilities plus generation by power plants owned by the central sector i.e. NTPC and NHPC etc. Specific quota is allocated to different states from the central sector power plants. Depending on the demand and generation there are exports and imports of power within different states in the regional grid. Thus there is trading of power between states in the grid. Similarly there are imports and export of power between regional grids**.**

Since the CDM project is connected to the regional grid it is also preferred to take the regional grid as project boundary than the state boundary. It also minimizes the effect of inter state power transactions, which are dynamic and vary widely.
Regional Grid selected: Southern Regional grid

A baseline emission factor (*EFy*) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps. A calculation for this combined margin is based on data from CEA which is publicly available.

Step 1:
Operating Margin: *Simple Operating Margin* –Simple OM is selected because low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years is taken for the calculation.
The simple Operating Margin (OM) emission factor ($EF_{OM,simple,y}$) is calculated as the average emission rate of all power plants, using equation (1) above, excluding low-operating cost and must-run power plants.

$$\mathbf{EF_{OM,\,simple,y} = \sum_{i,j} F_{i,j,y} \ X \ COEF_{i,j} / \sum_{j} GEN_{j,y}}$$

where:

- $\mathbf{F_{i,j,y}}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y, j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports4to the grid,
- $\mathbf{COEF_{i,j\,y}}$ is the CO_2 emission coefficient of fuel i (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- $\mathbf{GEN_{j,y}}$ is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as
$\mathbf{COEF_i = NCV_i \ X \ EFCO_{2,i} \ X \ OXID_i}$

where:

- **NCV_i** is the net calorific value (energy content) per mass or volume unit of a fuel i,
- **$OXID_i$** is the oxidation factor of the fuel
- **$EFCO_{2,i}$** is the CO2 emission factor per unit of energy of the fuel i.

Step 2: Build Margin:
The Build Margin emission factor *EFBM,y ex-ante* based on the most recent information available on plants already built for sample group *m*. The sample group *m* consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The Southern Regional grid has considered the second option .

Build Margin Emission factor as the generation-weighted average emission factor (tCO2/MWh) of a sample of power plants *m*, as follows:

$$\mathbf{EF_{BM,\,y} = \sum_{i,m} F_{i,m,y} \;X\; COEF_{i,m} / \sum_{m} GEN_{m,y}}$$

where:
$F_{i\ ,j,\ y}$, $COEF_{i,j\ y}$ and $GEN_{j,y}$ are analogous to the variables described for the simple OM method above for plants m.

Step 3: Baseline Emission Factor: as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$\mathbf{EF\ y = w_{OM}\ X\ EF_{OM,y} + w_{BM}\ X\ EF_{BM,y}}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh.

For the emission factor of self generating electricity

For cement plants that self-generate power, the average annual emission factor of the self generated power can be substituted by the emission factor calculated below.
The emission factor for self generation ($EF_{sg,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all self-generating sources in the project boundary serving the system.

$$\mathbf{EF_{sg,y} = \sum_{i,j} F_{i,j,y}\ X\ COEF_{i,j} / \sum_{j} GEN_{j,y}}$$

where:

- **$F_{i\ ,j,\ y}$** is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources
- **$COEF_{i,j\ y}$** is the CO_2 emission coefficient of fuel i (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- **$GEN_{j,y}$** is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as

$COEF_i = NCV_i \times EFCO_{2,i} \times OXID_i$

where:

- **NCV_i** is the net calorific value (energy content) per mass or volume unit of a fuel i,
- **$OXID_i$** is the oxidation factor of the fuel
- **$EFCO_{2,i}$** is the CO_2 emission factor per unit of energy of the fuel i.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

The additionally of the project activity shall be demonstrated and assessed using the latest version of the "Tool for the demonstration and assessment of additionally" agreed by the CDM Executive Board, available at the UNFCCC CDM web site.

Steps followed under the "Tool for the demonstration and assessment of additionally" are as follows:

Step 0. Preliminary screening of projects started after 1st January 2000 and prior to 31st December 2005.

The CDM was seriously considered by the management in the decision to proceed with the project activity. Such evidence is available in the form of background notes with the management, R & D dept and operation department; and exchange of information with a third party. This evidence is made available to the DOE and the Project Proponent can share this information in public domain.

Step 1. Identification of alternatives to the project activity consistent with current laws and regulations

Sub-step 1a. Define alternatives to the project activity:

Identification of baseline scenario
A possible set of alternative is drawn up which will be there in the absence of the CDM activity.
Alternative (a): The project activity without the CDM revenue
Alternative (b): Continue with existing practice of PSC production
Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances.
.

Sub-step 1b. Enforcement of applicable laws and regulations:
Production of PSC in India is subject to the Bureau of Indian Standards specification IS: 455: 1989. This states that the slag constituent shall be not less than 25% nor more than 65% of the Portland Slag cement. The BIS specification IS: 455: 1989, amendment-04, in 2000, has changed this specification in slag % from >65% to >70%. All the above mentioned alternatives meet this requirement.

Further it is required to conduct
Step 2 Investment Analysis or
Step 3 Barrier Analysis
MCL proceeds with the barrier analysis to ascertain project additionality.
Step 3 Barrier Analysis

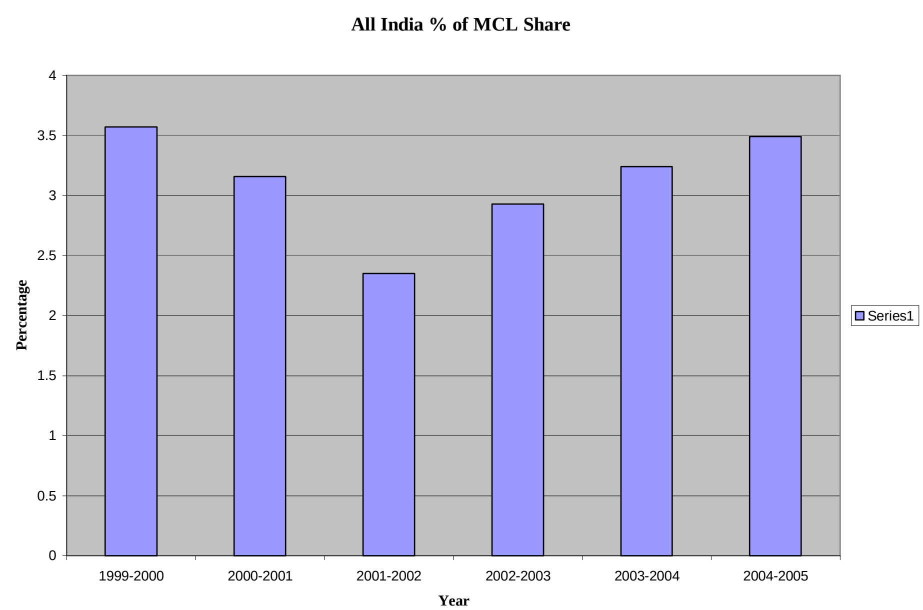
Sub-step 3a. Identify barriers that would prevent the implementation of type of the proposed project activity:

Investment barrier

The project activity involves investment in modification and replacement of grate plate and liner plate for middle diaphragm. It has increased the manufacturing cost due to excessive wear and tear of grinding media, liner plates etc, due to abrasive nature of slag. The project activity also involves costs associated with R & D, marketing promotion and brand building. The stockists were apprehensive that slag cement being slow setting may find strong resistance in the market; thereby affecting the sales.

The requirement of additional investment, possible increase of manufacturing costs and resistance from distribution channels, were prohibitive barriers for the MCL to undertake the project activity.

There is post facto evidence for all the above barriers e.g.,with increased percentage of slag, the market share of MC PSC had decreased which resulted in sales loss.



The above figure demonstrates that after increasing percentage of slag, the market share of MC PSC had decreased during the year 2001-2002 immediately after the project implementation

Such barriers did not exist for alternatives to the project activity i.e.,
Alternative (b): Continue with existing practice of PSC production
Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances.
.

Technological barrier

The operation and maintenance of ball mills in slag cement plants is the difficult one as the slag is abrasive and hard to grind. With increased percentage of slag addition in the PSC the wear rate inside the ball mill further increases. The lining material of the ball mills needs to be replaced frequently. MCL had installed modified high chrome boltless liner plates that reduces wear rate of lining plates and improves grinding. The liner plates are one of the main protectors of the mill shell. These high chrome boltless liners for cement millers resist wearing. The plant is also continuously replacing the grate plate for middle diaphragm and modified liner plate for middle diaphragm.

The quality of the cement from the slag cement route may not be comparable to that from OPC. The quality of slag generated varies depending on the input of raw materials which is a pre requisite based on the steel plant customer needs. As a result of which, the quality of slag varies which affects the quality of slag cement produced. Slag is harder to grind and hence requires more power for grinding. Because of this, the rate of production of cement is lower as compared to OPC.

This barrier and here say about maintenance / breakdowns of ball mills has infact prevented and delayed the project activity. The expectation of CDM component of this project has tilted the decision in favor of investment into increasing use of slag content in the PSC.

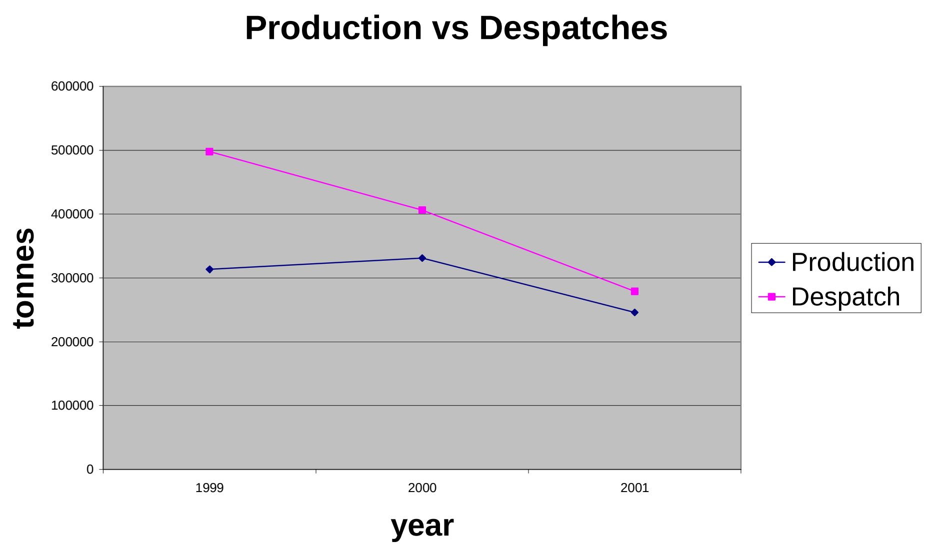
MCL had also conducted numerous trial testing and experiment to ascertain the impacts of different type of slag and clinker on quality of PSC. This has resulted in development of proper production and operation plan for increasing slag share in the PSC category cement production.

This is a prohibitive barrier as it has direct implication on productivity and O&M costs.

Such barriers did not exist for alternatives to the project activity i.e.,
Alternative (b): Continue with existing practice of PSC production
Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances.
.

Other barrier

Market acceptability barrier
Apart from above barriers, acceptability of an increase slag percentage in the PSC with similar characteristics is very low in market as public perception about such PSC is not favorable. The reason is - low early strength of the PSC cement. The grey white colour PSC also creates doubts in the market place due to colour variations between PSC and OPC. Consumers are yet to realize the advantage of the PSC and this is more so when project activity was being planned and implemented, than now. An increase of slag content from 26-27% to 45-60% by mass creates more doubt on the strength of the cement. The below figure demonstrates decreasing trend in dispatches of PSC cement at MCL during the years 1999-2001 , which justifies decreasing market demand for MCL PSC during that period This is attributed to increase percentage of slag in the PSC.



The government agencies like NHAI, State Govt Organisation and many others do not accept the use of blended cements. This leads to unnecessary doubts in the minds of other users about the quality & performance of PSC. Therefore PSC with a higher percentage of slag is unattractive.

The Union Government has also set a guideline that cement used in the national highway project must have 20 per cent flyash content. This too made blast furnace slag unattractive.[2]

MCL has taken up extra efforts in marketing and brand building to promote PSC with higher additive percentage. During 2001-2002 MCL launched a new brand as Birla Power and promoted it extensively with the previous Diamond brand cements. It had conducted some awareness and training programme as measures under the training programme.

This is a prohibitive barrier as the MCL could not have have taken risk with the market unless it ensured that risk –reward ratio is attractive and the risk is mitigated to some extent by spend market promotion.

Such barriers did not exist for alternatives to the project activity i.e.,
Alternative (b): Continue with existing practice of PSC production
Alternative (c): practices in other manufacturing plants in the region using similar input/raw materials, and facing similar economic, market and technical circumstances.
.
From the analysis above, project activity is not the feasible credible alternative scenario permitted by applicable regulations to the project participants.

Sub-step 3b. Show that the identified barriers would not prevent the implementation of at least one of the alternatives (except the project activity):
The alternative to the project activity alternative (ii) and alternative (iii) did not face any of the barriers delineated above.

[2] http://www.thehindubusinessline.com/2005/04/14/stories/2005041400131100.htm

Step 4. Common practice analysis
Sub-step 4a. Analyze other activities similar to the proposed project activity:
Sub-step 4b. Discuss any similar options that are occurring:

There are around 43 cement manufacturing plant in the region. Out of them only 6 cement plants including MCL, manufactures PSC. In addition, the shares of additives in the blended cements have not increased substantially as comparable to the MCL PSC share of additives in all the plants. The increase in share of slag in the PSC has occurred because of CDM project activity. Therefore, it is not a common practice in the region.

Step 5: Impact of CDM Registration

- Anthropogenic greenhouse gas emission reductions;
- It will continue to allow MCL to dedicate R&D and marketing effort to overcoming the barriers;
- The CDM registration could encourage other operators of similar nature to replicate such projects in their own entities.

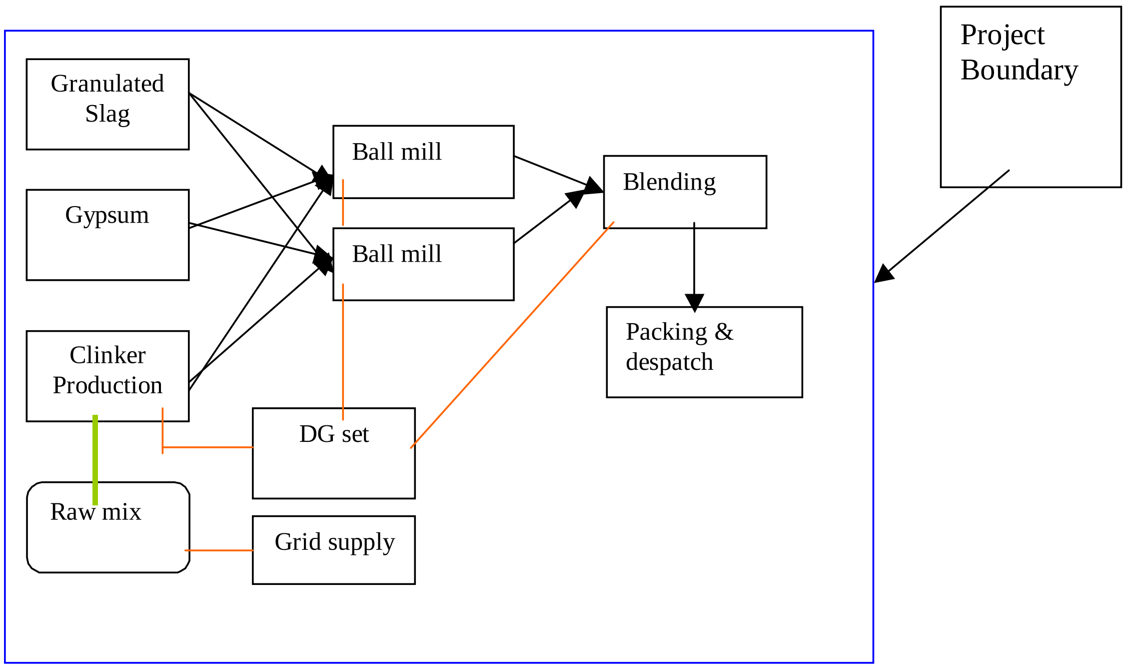
B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

>> The project boundary includes the cement production plant, any onsite power generation (if applicable), and the power generation in the grid (if applicable).
Project participants shall account for the following **emission sources:**

- Direct emissions at the cement plant due to fuel combustion for:
  - Firing the kiln (including supplemental fuels used in the precalciner);
  - Processing (including drying) of solid fuels, raw materials, and additives;
  - On-site generation of electricity (if applicable).
- Direct emissions due to calcination of limestone (i.e. calcium carbonate and magnesium carbonate, if present in the raw meal).
- Indirect emissions from fossil fuel combustion in power plants in the grid due to electricity use at the cement plant, including electricity consumption for:
  - Crushing and grinding the raw materials used for clinker production;
  - Driving the kiln and kiln fans;
  - Finish grinding of cement;
  - Processing of additives.

The power grid or plant from which the cement plant purchases electricity and its losses is considered in determining indirect emissions. Any transport related emissions for the delivery of additional additives is included in the emissions related to the project activity as leakage in a conservative approach. Emissions reductions from transport of raw materials for clinker production are not taken into account as a conservative simplification.

Gases included: CO_2 only. Changes in CH_4 and N_2O emissions from combustion processes are considered to be negligible and excluded because the differences in the baseline and project activity are not substantial. This assumption simplifies the methodology and is conservative.



B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

The current final PDD with baseline study was completed on 21/10/2005.
Care Sustainability whose contact information is (email: cdm.info@caresustainability.com), has assisted the Sponsor in determining the baseline methodology.
Care Sustainability is not a project participant.

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

>> The starting date of the project activity is 31/01/2000

C.1.2. Expected operational lifetime of the project activity:

>> Operational lifetime is estimated to be 20 years.

C.2 Choice of the crediting period and related information:

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

>> Not applicable (NA)

C.2.1.2. Length of the first crediting period:

>> Not applicable (NA)

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2001

C.2.2.2. Length:

>>10 years

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

Title: Consolidated Baseline Methodology for Increasing the Blend in Cement Production

Reference: Approved consolidated baseline methodology ACM0005 / Version 03, Sectoral Scope: 4, 19 May 2006.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The applicability conditions for the monitoring methodology are identical to that of the baseline methodology. Please refer to section B.1.1 for a detailed discussion.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1.1	$InCaO_y$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.2	$OutCaO_y$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.3	$InMgO_y$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.4	$OutMgO_y$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.5	Quantity of clinker raw material	Plant records	Kilo tonnes	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.6	$CLNK_y$	Plant records	Kilo tones	M	Annually	100%	Paper/electroni	Data will be archived

			of clinker				c	for 2 years beyond the end of crediting period.
1.7	$FF_{i\_,y}$	Plant records	Tonnes of fuel i	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.8	EFF_i	IPCC/ Plant records	tCO_2/tonne of fuel i	C/M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.9	$PELE_{grid\_CLNK,y}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.10	EF_{grid_BSL}	ACM 002 is used for the calculation	t CO_2/MWh	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.11	$PELE_{sg\_CLNK,y}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.12	EF_{sg_y}	Plant records/IPCC	t CO_2/MWh	C	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.13	ADD_y Quantity of additives	Plant records	Kilo tonnes	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.14	$PELE_{grid\_BC,y}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting

								period.
1.15	$PELE_{sg\_BC,y}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.16	$PELE_{grid\_ADD}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.17	$PELE_{sg\_ADD,y}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.18	$F_{i,j,y}$	Plant records	Tonnes of fuel i	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.19	$COEF_{i,j\ y}$	Plant records/IPCC	tCO_2/tonne of fuel i	C/M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.20	$GEN_{j,y}$	Plant records	MWh	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.21	$PE_{calcin,y}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.22	$PE_{fossil\_fuel,y}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

1.23	$PE_{ele\_grid\_CLNK,y}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.24	$PE_{ele\_sg\_CLNK,y}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.25	$PE_{ele\_grid\_BC,y}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.26	$PE_{ele\_sg\_BC,y}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.27	$PE_{ele\_grid\_ADD,y}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.28	$PE_{ele\_sg\_ADD,y}$	Plant records	t CO_2/tonne blended cement	c	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
1.29	$P_{blend,y}$	Plant records	Tonne of clinker/tonne of blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

$PE_{BC,y}$ are estimated as below. In the project activity plant emissions are determined per unit of clinker or per unit of BC accounting for

i. Emissions from calcinations of limestone;
ii. Emissions from combustion of fossil fuel and electricity for clinker production and processing of raw material;
iii. Emissions from electricity used for additives preparation and grinding of cement.

In determining the emissions reduction there are 3 possibilities:

i. emissions per tonne of clinker during the crediting period are less than baseline emissions per tonne of clinker ($PE_{Clinker,y} < BE_{Clinker}$); or
ii. baseline and year y emissions per tonne of clinker are equal ($PE_{Clinker,y} = BE_{Clinker}$);or
iii. emissions per tonne of clinker in year y are greater than the baseline emissions per tonne of clinker ($PE_{Clinker,y} > BE_{Clinker}$).

In case (i), the baseline value is substituted by the project activity value. That is, if emissions per tonne of clinker are lower during the crediting period, then the lower value is taken for the baseline.

In case (iii) the emissions per tonne of clinker are higher during the crediting period than the baseline. This could be due to declining efficiency or a fuel switch or some other reason. In this case, there is a possibility that project activity emissions exceed the baseline emissions for some years in the crediting period. In this case, the project does not get new credits for emissions reduction till the net balance for the project is positive. In the case that overall negative emission reductions arise in a year, ERs are not issued to project participants for the year concerned and in subsequent years, until emission reductions from subsequent years have compensated the quantity of negative emission reductions from the year concerned.

$$PE_{BC,y} = [PE_{clinker,y} * P_{Blend,y}] + PE_{ele\_ADD\_BC,y}$$

where:

$PE_{BC,y}$ = CO_2 emissions per tonne of BC in the project activity plant in year y(t CO_2/tonne BC)
$PE_{clinker,y}$ = CO_2 emissions per tonne of clinker in the project activity plant in year y (t CO2/tonne clinker) and defined below
$P_{Blend,y}$ = Share of clinker per tonne of BC in year y (tonne of clinker/tonne of BC)
$PE_{ele\_AD,D\_BC,y}$ = Electricity emissions for BC grinding and preparation of additives in year y (tCO_2/tonne of BC) CO_2 per tonne of clinker in the project activity plant in year y is calculated as below:

$$PE_{clinker,y} = PE_{calcin,y} + PE_{fossil\_fuel,}y + PE_{ele\_grid\_CLNK,y} + PE_{ele\_sg\_CLNK,y}$$

where:

$PE_{clinker,y}$ = Emissions of CO_2 per tonne of clinker in the project activity plant in year y (t CO_2/tonne clinker)
$PE_{calcin,y}$ = Emissions per tonne of clinker due to calcinations of calcium carbonate and magnesium carbonate in year y (t CO_2/tonne clinker)
$PE_{fossil\_fuel,}y$ = Emissions per tonne of clinker due to combustion of fossil fuels for clinker production in year y (t CO_2/tonne clinker)
$PE_{ele\_grid\_CLNK,y}$ = Grid electricity emissions for clinker production per tonne of clinker in year y (t CO_2/tonne clinker)
PEele_sg_CLNK,y = Emissions from self-generated electricity per tonne of clinker production in year y (t CO_2/tonne clinker)

$PE_{calcin,y}$ = 0.785*(OutCaOy - InCaOy) + 1.092*(OutMgOy - InMgOy) / [CLNKy * 1000]
where:
$PE_{calcin,y}$ = Emissions from the calcinations of limestone (tCO_2/tonne clinker)
0.785 = Stoichiometric emission factor for CaO (tCO_2/t CaO)
1.092 = Stoichiometric emission factor for MgO (tCO_2/t MgO)
InCaO,$_y$ = CaO content (%) of the raw material * raw material quantity (tonnes)
OutCaO,$_y$ = CaO content (%) of the clinker * clinker produced (tonnes)
InMgO,$_y$ = MgO content (%) of the raw material * raw material quantity (tonnes)
OutMgO,$_y$ = MgO content (%) of the clinker * clinker produced (tonnes)
$PE_{fossil\_fuel, y}$ = [$\sum FF_{i\_,y}$ * EFF_i] /CLNK,$_y$ * 1000
where:
$FF_{i\_,y}$ = Fossil fuel of type i consumed for clinker production in year y (tonnes of fuel i)
EFF_i = Emission factor for fossil fuel i (tCO_2/tonne of fuel)
$CLNK_y$ = Annual production of clinker in year y (kilotonnes of clinker)
$PE_{ele\_grid\_CLNK,y}$ = [$PELE_{grid\_CLNK,y}$ * EF_{grid_y}] / [$CLNK_y$* 1000]
where:
$PELE_{grid\_CLNK,y}$ = Grid electricity for clinker production in year y (MWh)
EF_{grid_y} = Grid emission factor in year y(t CO_2/MWh)
$CLNK_y$ = Annual production of clinker in year y (kilotonnes of clinker)

$PE_{elec_sg_CLNK,}$y = [$PELE_{sg\_CLNK\ ,y}$* EF_{sg_y}] /[$CLNK_y$ * 1000]
where:
$PELE_{sg\_CLNK,y}$ = Self generation of electricity for clinker production in year y (MWh)
EF_{sg_y} = Emission factor for self generated electricity in year y (t CO_2/MWh)
$CLNK_y$ = Annual production of clinker in year y (kilotonnes of clinker)
$PE_{ele\_ADD\_BC,y}$ = $PE_{ele\_grid\_BC,y}$ + $PE_{ele\_sg\_BC,y}$ + $PE_{ele\_grid\_ADD,y}$ + $PE_{ele\_sg\_ADD,y}$
where:
$PE_{ele\_grid\_BC}$ = Grid electricity emissions for BC grinding in year y (tCO_2/tonne of BC)
$PE_{ele\_sg\_BC}$ = Emissions from self generated electricity for BC grinding in year y (tCO_2/tonne of BC)
$PE_{ele\_grid\_ADD}$ = Grid electricity emissions for additive preparation in year y (tCO_2/tonne of BC)
$PE_{ele\_sg\_ADD}$ = Emissions from self generated electricity additive preparation in year y (tCO_2/tonne of BC)

$PE_{ele\_grid\_BC,y}$ = [$PELE_{grid_BC,}$y * $EF_{grid\_BSL,y}$] /[BC_y* 1000]
$PELE_{grid\_BC,y}$ = Baseline grid electricity for grinding BC (MWh)

EF_{grid_y} = Grid emission factor in year y(t CO_2/MWh)
BC_y = Annual production of BC in year y (kilotonnes of BC)

$$\mathbf{PE_{elec\_sg\_BC,y} = [PELE_{sg\_BC,y} * EF_{sg\_y}] / [BC_y * 1000]}$$

$PELE_{sg\_BC,y}$ = Self generated electricity for grinding BC in year y (MWh)
EF_{sg_y} = Emission factor for self generated electricity in year y (t CO_2/MWh)
BC_y = Annual production of BC in year y (kilotonnes of BC)

$$\mathbf{PE_{ele\_grid\_ADD} = [PELE_{grid\_ADD} * EF_{grid\_y}] /[BC_y * 1000]}$$

$BELE_{grid\_ADD}$ = Baseline grid electricity for grinding additives (MWh)
EF_{grid_y} = Grid emission factor in year y(t CO_2/MWh)
BC_y = Annual production of BC in year y (kilotonnes of BC)
This figure is zero because the project activity grinds additives with the clinker.

$$\mathbf{PE_{elec\_sg\_ADD,y} = [PELE_{sg\_ADD,y} * EF_{sg\_y}] / [BC_y * 1000]}$$

$PELE_{sg\_ADD,y}$ = Baseline self generation electricity for grinding additives (MWh)
EF_{sg_y} = Emission factor for self generated electricity in year y (t CO_2/MWh)
BC_y = Annual production of BC in year y (kilotonnes of BC)

This figure is zero because the project activity grinds additives with the clinker.

A baseline emission factor (EFy) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps. Calculations for this combined margin is based on data from CEA which is publicly available.

Step 1:

Operating Margin: ***Simple Operating Margin*** **–Simple OM** is selected because low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years is taken for the calculation.

The simple Operating Margin (OM) emission factor (EFOM,simple,y) is calculated as the average emission rate of all power plants, using equation (1) above, excluding low-operating cost and must-run power plants.

$$\mathbf{EF_{OM,\ simple,y} = \sum_{i,j} F_{i,j,y}\ X\ COEF_{i,j} / \sum_{j} GEN_{j,y}}$$

where:

- $\mathbf{F_{i\ ,j,\ y}}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y, j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports4to the grid,
- $\mathbf{COEF_{i,j\ y}}$ is the CO_2 emission coefficient of fuel i (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and

- **$GEN_{j,y}$** is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as

$COEF_i = NCV_i \times EFCO_{2,i} \times OXID_i$

where:

- **NCV_i** is the net calorific value (energy content) per mass or volume unit of a fuel i,
- **$OXID_i$** is the oxidation factor of the fuel
- **$EFCO_{2,i}$** is the CO2 emission factor per unit of energy of the fuel i.

Step 2: Build Margin: The Build Margin emission factor *EFBM,y ex-ante* based on the most recent information available on plants already built for sample group *m*. The sample group *m* consists of either the five power plants that have been built most recently or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The Southern Regional grid has considered the second option.

Build Margin Emission factor as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,y} = \sum_{i,m} F_{i,m,y} \times COEF_{i,m} / \sum_{m} GEN_{m,y}$$

where:

$F_{i,j,y}$, **$COEF_{i,j\,y}$** and **$GEN_{j,y}$** are analogous to the variables described for the simple OM method above for plants m.

Step 3: Baseline Emission Factor: as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF_y = w_{OM} \times EF_{OM,y} + w_{BM} \times EF_{BM,y}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh.

For the emission factor of self generating electricity

For cement plants that self-generate power, the average annual emission factor of the self generated power can be substituted by the emission factor calculated below.

The emission factor for self generation ($EF_{sg,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO2/MWh) of all self-generating sources in the project boundary serving the system.

$$EF_{sg,y} = \sum_{i,j} F_{i,j,y} \text{ X } COEF_{i,j} / \sum_j GEN_{j,y}$$

where:

- $F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources
- $COEF_{i,j\,y}$ is the CO_2 emission coefficient of fuel i (tCO_2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as

$$COEF_i = NCV_i \text{ X } EFCO_{2,i} \text{ X } OXID_i$$

where:

- NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel i,
- $OXID_i$ is the oxidation factor of the fuel
- $EFCO_{2,i}$ is the CO2 emission factor per unit of energy of the fuel i.

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
2.1	$InCaO_{BSL}$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

2.2	$OutCaO_{BSL}$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.3	$InMgO_{BSL}$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.4	$OutMgO_{BSL}$	Plant records	%	M, C	Daily	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.5	Quantity of clinker raw material	Plant records	Kilo tonnes	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.6	$CLNK_{BSL}$	Plant records	Kilo tones of clinker	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.7	$FF_{i\_,BSL}$	Plant records	Tonnes of fuel i	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.8	EFF_i	IPCC/ Plant records	tCO_2/tonne of fuel i	C/M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.9	$BELE_{grid\_CLNK,BSL}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

2.10	EF_{grid_BSL}	ACM 002 is used for the calculation	t CO_2/MWh	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.11	$BELE_{sg\_CLNK,BSL}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.12	EF_{sg_BSL}	Plant records/IPCC	t CO_2/MWh	C	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.13	ADD_{BSL}Quantity of additives	Plant records	Kilo tonnes	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.14	$BELE_{grid\_BC,BSL}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.15	$BELE_{sg\_BC,BSL}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.16	$BELE_{grid\_ADD}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.17	$BELE_{sg\_ADD,BSL}$	Plant records	MWh	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

2.18	$F_{i,j,BSL}$	Plant records	Tonnes of fuel i	M	Monthly	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.19	$COEF_{i,j BSL}$	Plant records/IPCC	tCO_2/tonne of fuel i	C/M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.20	$GEN_{j,BSL}$	Plant records	MWh	M	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.21	$BE_{calcin,BSL}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.22	$BE_{fossil\_fuel,BSL}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.23	$BE_{ele\_grid\_CLNK,BSL}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.24	$BE_{ele\_sg\_CLNK,BSL}$	Plant records	t CO_2/tonne clinker	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.25	$BE_{ele\_grid\_BC,BSL}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

2.26	$BE_{ele\_sg\_BC,BSL}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.27	$BE_{ele\_grid\_ADD,BSL}$	Plant records	t CO_2/tonne blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.28	$BE_{ele\_sg\_ADD,BSL}$	Plant records	t CO_2/tonne blended cement	c	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.
2.29	$A_{blend,y}$	Plant records	Tonne of additives/tonne of blended cement	C	Annually	100%	Paper/electronic	Data will be archived for 2 years beyond the end of crediting period.

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

>> $\mathbf{BE_{BC,y} = [BE_{clinker} * B_{Blend,y}] + BE_{ele\_ADD\_BC}}$

where:

$BE_{BC,y}$ = Baseline CO_2 emissions per tonne of blended cement type (BC) (t CO_2/tonne BC)

$BE_{clinker}$ = CO_2 emissions per tonne of clinker in the baseline in the project activity plant (t CO_2/tonne clinker) and defined below

$B_{Blend,y}$ = Baseline benchmark of share of clinker per tonne of BC updated for year y (tonne of clinker/tonne of BC)

$BE_{ele\_ADD\_BC}$ = Baseline electricity emissions for BC grinding and preparation of additives (tCO_2/tonne of BC)

CO_2 per tonne of clinker in the project activity plant in the baseline is calculated as below:

$\mathbf{BE_{clinker} = BE_{calcin} + BE_{fossil\_fuel} + BE_{ele\_grid\_CLNK} + BE_{ele\_sg\_CLNK}}$

where:

BE_{clinke}r = Baseline emissions of CO_2 per tonne of clinker in the project activity plant (t CO_2/tonne clinker)

BE_{calcin} = Baseline emissions per tonne of clinker due to calcinations of calcium carbonate and magnesium carbonate (t CO_2/tonne clinker)

BE_{fossil_fuel} = Baseline emissions per tonne of clinker due to combustion of fossil fuels for clinker production (t CO_2/tonne clinker)

$BE_{ele\_grid\_CLNK}$ = Baseline grid electricity emissions for clinker production per tonne of clinker (t CO_2/tonne clinker)
$BE_{ele\_sg\_CLNK}$ = Baseline emissions from self generated electricity for clinker production per tonne of clinker (t CO_2/tonne clinker)
BE_{calcin} = [0.785*(OutCaO - InCaO) + 1.092*(OutMgO - InMgO)] / [CLNKBSL * 1000]
where:
BE_{calcin} = Emissions from the calcinations of limestone (tCO_2/tonne clinker)
0.785 = Stoichiometric emission factor for CaO (tCO_2/t CaO)
1.092 = Stoichiometric emission factor for MgO (tCO_2/t MgO)
InCaO = CaO content (%) of the raw material * raw material quantity (tonnes)
OutCaO = CaO content (%) of the clinker * clinker produced (tonnes)
InMgO = MgO content (%) of the raw material * raw material quantity (tonnes)
OutMgO = MgO content (%) of the clinker * clinker produced (tonnes)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilotonnes of clinker)

$BE_{fossil\_fuel} = [\sum FF_{i\_BSL} * EFFi] / [CLNK_{BSL} * 1000]$
FF_{i_BSL} = Fossil fuel of type i consumed for clinker production in the baseline (tones of fuel i)
EFF_i = Emission factor for fossil fuel i (t CO_2/tonne of fuel)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilotonnes of clinker)
$BE_{ele\_grid\_CLNK} = [BELE_{grid\_CLNK} * EF_{grid\_BSL}] / CLNK_{BSL} * 1000$
$BELE_{grid\_CLNK}$ = Baseline grid electricity for clinker production (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilotonnes of clinker)

$BE_{elec\_sg\_CLNK} = [BELE_{sg\_CLNK} * EFs_{g\_BSL}] / [CLNK_{BSL} * 1000]$
$BELE_{sg\_CLNK}$ = Baseline self generation of electricity for clinker production (MWh)
$EFsg_{\_BSL}$ = Baseline electricity self generation emission factor (t CO_2/MWh)
$CLNK_{BSL}$ = Annual production of clinker in the base year (kilotonnes of clinker)

$BE_{ele\_ADD\_BC} = BE_{ele\_grid\_BC} + BE_{ele\_sg\_BC} + BE_{ele\_grid\_ADD} + BE_{ele\_sg\_ADD}$
where:
$BE_{ele\_grid\_BC}$ = Baseline grid electricity emissions for BC grinding (tCO_2/tonne of BC)
$BE_{ele\_sg\_BC}$ = Baseline self generated electricity emissions for BC grinding (tCO_2/tonne of BC)
$BE_{ele\_grid\_ADD}$ = Baseline grid electricity emissions for additive preparation (tCO_2/tonne of BC)
$BE_{ele\_sg\_ADD}$ = Baseline self generated electricity emissions for additive preparation (tCO_2/tonne of BC)
$BE_{ele\_grid\_BC} = [BELE_{grid\_BC} * EF_{grid\_BSL}] / [BC_{BSL} * 1000]$

$BELE_{grid\_BC}$ = Baseline grid electricity for grinding BC (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilotonnes of BC)

$$BE_{elec\_sg\_BC} = [BELE_{sg\_BC} * EF_{sg\_BSL}] / [BC_{BSL} * 1000]$$

$BELE_{sg\_BC}$ = Baseline self generation electricity for grinding BC (MWh)
EF_{sg_BSL} = Baseline electricity self generation emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilotonnes of BC)

$$BE_{ele\_grid\_ADD} = [BELE_{grid\_ADD} * EF_{grid\_BSL}] /[BC_{BSL} * 1000]$$

$BELE_{grid\_ADD}$ = Baseline grid electricity for grinding additives (MWh)
EF_{grid_BSL} = Baseline grid emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilotonnes of BC)
The factor (**$BE_{ele\_grid\_ADD}$**) is zero because slag is grinded with clinker in the ball mill.

$$BE_{elec\_sg\_ADD} = [BELE_{sg\_ADD} * EFsg\_BSL] / [BC_{BSL} * 1000]$$

$BELE_{sg\_BC}$ = Baseline self generation electricity for grinding additives (MWh)
EF_{sg_BSL} = Baseline electricity self generation emission factor (t CO_2/MWh)
BC_{BSL} = Annual production of BC in the base year (kilotonnes of BC)

The factor (**$BE_{elec\_sg\_ADD}$**) is zero because slag is grinded with clinker in the ball mill.

For the calculation of the specific emissions from power generation from the grid (EF_{grid_BSL} or $_{y}$) the approved consolidated baseline methodology ACM0002 is applied. The Southern regional grid is considered as the grid which is supplying electricity to the project activity.

Justification for Southern grid: In India, power is a concurrent subject between the state and the central governments. The perspective planning, monitoring of implementation of power projects is the responsibility of Ministry of Power, Government of India. At the state level the state utilities or state electricity boards (SEBs) are responsible for supply, transmission, and distribution of power. With power sector reforms there have been unbundling and privatization of this sector in many states. Many of the state utilities are engaged in power generation also. In addition to this there are different central / public sector organizations involved in generation like National Thermal Power Corporation (NTPC), National Hydro Power Corporation (NHPC), etc. in transmission e.g. Power Grid Corporation of India Ltd. (PGCIL) and in financing e.g. Power Finance Corporation Ltd. (PFC). There are five regional grids: Northern, Western, Southern, Eastern and North-Eastern. Different states are connected to one of the five regional grids as shown in the below table.

Northern	Western	Southern	Eastern	North Eastern
Haryana	Gujurat	AP	Bihar	Assam
HP	MP	Karnataka	Jharkhand	Manipur
JK	Chhattisgarh	Kerala	Orissa	Meghalaya
Rajasthan	Maharashtra	TN	WB	Nagaland
UP	Goa	Lakshadweep	D.V.C	Tripura
Uttarnanchal	D.N.H	Pondicherry	A&N	Arunachal Pradesh
Chandigarh	Daman& Diu		Sikkim	Mizoram
Delhi				

The management of generation and supply of power within the regional grid is undertaken by the load dispatch centres (LDC). Different states within the regional grids meet the demand from their own generation facilities plus generation by power plants owned by the central sector i.e. NTPC and NHPC etc. Specific quota is allocated to different states from the central sector power plants. Depending on the demand and generation there are exports and imports of power within different states in the regional grid. Thus there is trading of power between states in the grid. Similarly there are imports and export of power between regional grids.

Since the CDM project is connected to the regional grid it is also preferred to take the regional grid as project boundary than the state boundary. It also minimizes the effect of inter state power transactions, which are dynamic and vary widely.

Regional Grid selected: Southern Regional grid

A baseline emission factor (*EFy*) is calculated as a combined margin (*CM*), consisting of the combination of operating margin (*OM*) and build margin (*BM*) factors according to the following three steps. Calculations for this combined margin is based on data from CEA which is publicly available.

Step 1:

Operating Margin: ***Simple Operating Margin*** **–Simple OM** is selected because low-cost/must run resources constitute less than 50% of total grid generation in: 1) average of the five most recent years is taken for the calculation.

The simple Operating Margin (OM) emission factor (EFOM,simple,y) is calculated as the average emission rate of all power plants, using equation (1) above, excluding low-operating cost and must-run power plants.

$$EF_{OM,\,simple,y} = \sum_{i,j} F_{i,j,y} \text{ X } COEF_{i,j} / \sum_{j} GEN_{j,y}$$

where:

- $F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources j in year(s) y, j refers to the power sources delivering electricity to the grid, not including low-operating cost and must-run power plants, and including imports4to the grid,

- **$COEF_{i,j\ y}$** is the CO_2 emission coefficient of fuel i (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- **$GEN_{j,y}$** is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as
$COEF_i = NCV_i \text{ X } EFCO_{2,i} \text{ X } OXID_i$

where:

- **NCV_i** is the net calorific value (energy content) per mass or volume unit of a fuel i,
- **$OXID_i$** is the oxidation factor of the fuel
- **$EFCO_{2,i}$** is the CO2 emission factor per unit of energy of the fuel i.

Step 2: Build Margin: The Build Margin emission factor *EFBM,y ex-ante* based on the most recent information available on plants already built for sample group *m*. The sample group *m* consists of either the five power plants that have been built most recently, or the power plant capacity additions in the electricity system that comprise 20% of the system generation (in MWh) and that have been built most recently.

The Southern Regional grid has considered the second option .

Build Margin Emission factor as the generation-weighted average emission factor (tCO_2/MWh) of a sample of power plants *m*, as follows:

$$EF_{BM,\ y} = \sum_{i,m} F_{i,m,y} \text{ X } COEF_{i,m} / \sum_{m} GEN_{m,y}$$

where:
$F_{i\ ,j,\ y}$, **$COEF_{i,j\ y}$** and **$GEN_{j,y}$** are analogous to the variables described for the simple OM method above for plants m.

Step 3: Baseline Emission Factor: as the weighted average of the Operating Margin emission factor ($EF_{OM,y}$) and the Build Margin emission factor ($EF_{BM,y}$):

$$EF\ y = w_{OM} \text{ X } EF_{OM,y} + w_{BM} \text{ X } EF_{BM,y}$$

where the weights w_{OM} and w_{BM}, by default, are 50% (i.e., $w_{OM} = w_{BM} = 0.5$), and $EF_{OM,y}$ and $EF_{BM,y}$ are calculated as described in Steps 1 and 2 above and are expressed in tCO_2/MWh.

For the emission factor of self generating electricity

For cement plants that self-generate power, the average annual emission factor of the self generated power can be substituted by the emission factor calculated below.

The emission factor for self generation ($EF_{sg,y}$) is calculated as the generation-weighted average emissions per electricity unit (tCO_2/MWh) of all self-generating sources in the project boundary serving the system.

$$EF_{sg,y} = \sum_{i,j} F_{i,j,y} \times COEF_{i,j} / \sum_j GEN_{j,y}$$

where:

- $F_{i,j,y}$ is the amount of fuel i (in a mass or volume unit) consumed by relevant power sources
- $COEF_{i,j\,y}$ is the CO_2 emission coefficient of fuel i (tCO2 / mass or volume unit of the fuel), taking into account the carbon content of the fuels used by relevant power sources j and the percent oxidation of the fuel in year(s) y, and
- $GEN_{j,y}$ is the electricity (MWh) delivered to the grid by source j.

The CO_2 emission coefficient COEFi is obtained as

$$COEF_i = NCV_i \times EFCO_{2,i} \times OXID_i$$

where:

- NCV_i is the net calorific value (energy content) per mass or volume unit of a fuel i,
- $OXID_i$ is the oxidation factor of the fuel
- $EFCO_{2,i}$ is the CO_2 emission factor per unit of energy of the fuel i.

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Left blank as it is not applicable

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

Not Applicable

D.2.3. Treatment of leakage in the monitoring plan

D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
3.1	TF_{cons}	Plant records	kg of fuel/kilometre	C	Annually	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.
3.2	D_{add_source}	Plant records	km	M	Per trip	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting

								period.
3.3	TEF	Plant Record	kg CO_2/kg of fuel	E	Annually	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.
3.4	Q_{add}	Plant records	Tonnes of additive /vehicle	M	Per trip	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.
3.5	$ELE_{conveyor\_ADD}$	Plant records	MWh	M	Monthly	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.
3.6	EF_{grid}	National grid/plant data (if onsite generation)	Tonnes of CO_2/MWh	C	Annually	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.
3.7	α_y	Plant records	Tonnes of additive	M/C	Annually	100%	Paper/Electronic	Data will be archived for 2 years beyond the end of crediting period.

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Transport related emissions for additives are calculated as below.

$L_{add\_trans} = [(TF_{cons} * D_{add\_source} * TEF) * 1/Q_{add} * 1/1000 + (ELE_{conveyor\_ADD} * EF_{grid}) * 1/ADD_Y]$

where:

L_{add_trans} = Transport related emissions per tonne of additives (t CO2/tonne of additive)
TF_{cons} = Fuel consumption for the vehicle per kilometre (kg of fuel/kilometre)
D_{add_source} = Distance between the source of additive and the project activity plant(km)
TEF = Emission factor for transport fuel (kg CO2/kg of fuel)
$ELE_{conveyor\_ADD}$ = Annual Electricity consumption for conveyor system for additives (MWh)
EF_{grid} = Grid electricity emission factor (tonnes of CO_2/MWh)
Q_{add} = Quantity of additive carried in one trip per vehicle (tonnes of additive)
ADD_Y = Annual consumption of additives in year y. (t of additives)
And leakage emissions per tonne of BC due to additional additives are determined by
$L_y = L_{add\_trans} * [A_{blend,y} – P_{blend,y}] * BC_y$ where:
L_y = Leakage emissions for transport of additives (kilotonnes of CO_2)
BC_y = Production of BC in year y (kilotonnes of BC)
$A_{blend,y}$=Baseline benchmark share of additives per tonne of BC updated for year y (tonne of additives/tonne of BC)
$P_{blend,y}$ = Share of additives per tonne of BC in year y (tonne of additives/tonne of BC)
The additional amounts of slag used are surplus slag available in the region. Therefore leakage due to the diversion of additives from existing use is not considered.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

$ER_y = \{ [BE_{BC,y} – PE_{BC,y}] * BC_y + L_y \} * (1 – \alpha_y)$

where:

ER_y = Emissions reductions in year y due to project activity (thousand tonnes of CO2)
$BE_{BC,y}$ = Baseline emissions per tonne of BC (t CO2/tonnes of BC)
$PE_{BC,y}$ = Project emissions per tonne of BC in year y (t CO2/tonnes of BC)
BC_y = BC production in year y (thousand tonnes)

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored

Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1.1-1.29 2.1-2.29	Low	These data is collected as part of normal plant level operations. QA/QC requirements consist of cross – checking these with other internal company reports. Local data and where applicable IPCC data has been used.
3.1-3.7	Medium	These data is collected at the sales and purchase department.

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

>> The project is operated and managed by MCL who is the project proponent. MCL has ensured safety in operation of the plant as per plant management plan prepared for the site. The site has a CDM project activity monitoring plan and would be constituent of operational and management structure of this EMS.

Director has constituted the CDM project team, which is responsible for the project activity. The monitoring and verification of the project activity is assigned to the eight member team which is responsible for monitoring, verification and recording of the data. On a daily basis the monitoring reports is checked by the operation head. In case of any irregularity in the project activity it is reported to the operation head. On a monthly basis this report is forwarded to the Senior Executive and Director.

D.5 Name of person/entity determining the monitoring methodology:

>> Care Sustainability (email: cdm.info@caresustainability.com) as assisted the Sponsor in determining the monitoring methodology.
CARE Sustainability is not a project participant.

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Estimation of GHG Emissions by sources in a year y is done using the formula
$PE_{BC,y}$ x BC_y

where
$PE_{BC,y}$ = Project emissions per tonne of BC in year y (t CO_2/tonnes of BC)
BC_y = BC production in year y (thousand tonnes)

Year	CO_2 emissions per tonne of BC production in the Project activity	Quantity of BC	Emission from the sources
	t CO_2 /tonnes of BC	tonnes	t CO_2 e
2001	0.587873397	245967	144597
2002	0.534557505	354345	189418
2003	0.54037923	374138.39	202177
2004	0.536685015	379136.01	203477
2005	0.526570363	379136.01	199642
2006	0.516788302	379136.01	195933
2007	0.487442118	379136.01	184807
2008	0.467877995	379136.01	177389
2009	0.458095934	379136.01	173681
2010	0.438531811	379136.01	166263

E.2. Estimated leakage:

Transport related emissions for additives are calculated as below.

$$\mathbf{L_{add\_trans} = [(TF_{cons} * D_{add\_source} * TEF) * 1/Q_{add} * 1/1000 + (ELE_{conveyor\_ADD} * EF_{grid}) * 1/ADD_Y]}$$

where:
L_{add_trans} = Transport related emissions per tonne of additives (t CO2/tonne of additive)
TF_{cons} = Fuel consumption for the vehicle per kilometre (kg of fuel/kilometre)
D_{add_source} = Distance between the source of additive and the project activity plant(km)
TEF = Emission factor for transport fuel (kg CO2/kg of fuel)
$ELE_{conveyor\_ADD}$ = Annual Electricity consumption for conveyor system for additives (MWh)
EF_{grid} = Grid electricity emission factor (tonnes of CO_2/MWh)
Q_{add} = Quantity of additive carried in one trip per vehicle (tonnes of additive)
ADD_Y = Annual consumption of additives in year y. (t of additives)
And leakage emissions per tonne of BC due to additional additives are determined by
$L_y = L_{add\_trans} * [A_{blend,y} – P_{blend,y}] * BC_y$ where:
L_y = Leakage emissions for transport of additives (kilotonnes of CO_2)
BC_y = Production of BC in year y (kilotonnes of BC)
$A_{blend,y}$=Baseline benchmark share of additives per tonne of BC updated for year y (tonne of additives/tonne of BC)

$P_{blend,y}$ = Share of additives per tonne of BC in year y (tonne of additives/tonne of BC)
The additional amounts of slag used are surplus slag available in the region. Therefore leakage due to the diversion of additives from existing use is not considered.

Year	Leakage
	t CO_2 e
2001	-241
2002	-347
2003	-220
2004	-245
2005	-254
2006	-261
2007	-331
2008	-370
2009	-377
2010	-416

E.3. The sum of E.1 and E.2 representing the project activity emissions:

>>

Year	Emission from the sources	Leakage	Project activity emissions
	t CO_2 e	t CO_2 e	t CO_2 e
2001	144597	-241	144357
2002	189418	-347	189071
2003	202177	-220	201957
2004	203477	-245	203231
2005	199642	-254	199388
2006	195933	-261	195672
2007	184807	-331	184476
2008	177389	-370	177020
2009	173681	-377	173304
2010	166263	-416	165847

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

>> **$BE_{BC,y} = [BE_{clinker} * B_{Blend,y}] + BE_{ele\_ADD\_BC}$**

where:
$BE_{BC,y}$ = Baseline CO_2 emissions per tonne of blended cement type (BC) (t CO_2/tonne BC)
$BE_{clinker}$ = CO_2 emissions per tonne of clinker in the baseline in the project activity plant (t CO_2/tonne clinker) and defined below
$B_{Blend,y}$ = Baseline benchmark of share of clinker per tonne of BC updated for year y (tonne of clinker/tonne of BC)
$BE_{ele\_ADD\_BC}$ = Baseline electricity emissions for BC grinding and preparation of additives (tCO_2/tonne of BC)

Year	CO_2 emissions per tonne of BC production in the baseline	Quantity of BC	Baseline emissions
	t CO_2 /tonnes of BC	tonnes	t CO_2 e
2001	0.640430213	245967	157525
2002	0.632715554	354345	224200
2003	0.625000895	374138.39	233837
2004	0.617286237	379136.01	234035
2005	0.609571578	379136.01	231111
2006	0.60185692	379136.01	228186
2007	0.594142261	379136.01	225261
2008	0.586427602	379136.01	222336
2009	0.578712944	379136.01	219411
2010	0.570998285	379136.01	216486

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

=E4-E3

Year	Emission Reductions
	t CO_2 e
2001	13168
2002	35129
2003	31880
2004	30804
2005	31722
2006	32514
2007	40785

2008	45316
2009	46107
2010	50639

E.6. Table providing values obtained when applying formulae above:

Year	Estimation of project activity emissions (tonnes of CO2e)	Estimation of baseline emissions (tonnes of CO2e)	Estimation of leakages (tonnes of CO2e)	Estimation of emission reductions (tonnes of CO2e)
2001	144597	157525	-241	13168
2002	189418	224200	-347	35129
2003	202177	233837	-220	31880
2004	203477	234035	-245	30804
2005	199642	231111	-254	31722
2006	195933	228186	-261	32514
2007	184807	225261	-331	40785
2008	177389	222336	-370	45316
2009	173681	219411	-377	46107
2010	166263	216486	-416	50639
Total (tonnes of CO_2e)	1837383	2192386	-3061	358064

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>> This Environmental Impact Assessment for the project activity is not required by the Environmental Impact Assessment notification under Environment Protection Act (Government of India) and hence not conducted as per the requirement of guidelines there under. This assessment is conducted for Mysore Cements Limited., as a voluntary initiative to understand the impacts and mitigate any additional impacts that may arise due to the proposed project activity.

The environmental impacts of the project are negligible– the project activity represents an increase in existing percentage of slag in the cement production. The reduction in clinker percentage per tonne of cement produced reduces adverse environmental impact related to calcinations of limestone, slag disposal and conserve natural resources like limestone and coal. The cement has got superb resistance to Sulphate and chloride and hence specially suitable and highly advantageous for construction in coastal areas as it contains slag and lower C_3A content. It also gives higher long term and strength and durability to the concretes. Due to PSC lower heat of hydration as it contains slag, it is most suitable for mass concreting works like dams, bridges etc. so that the thermal cracking is reduced. This creates saving for

contractors, builders etc. Reduction in clinker production conserves energy. This improves the power availability in the region and assists overall economic development of the region.

The project activity ensures improvement in local and global environment through increasing percentage of slag. It does not have significant negative environmental impact. It is a step towards addressing issues related to climate change and global warming.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>> The environmental impacts are considered not significant. Each year the plant also obtains consent to operate from the relevant pollution control board.

SECTION G. Stakeholders' comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:

>> The stakeholders for the project activity were identified at the outset by a team of MCL staff and the stakeholders were duly informed of the consultation meeting. In addition public notices were also issued for the local stakeholder consultation meeting. Local stakeholder consultation meeting to discuss stakeholder concerns on the proposed Clean Development Mechanism (CDM) project – MCL Portland Slag Cement project, was held at 11:00 a.m. on 24th October 2005 at the Conference Hall, Mysore Cements Limited, Ammsandra, Taluka: Turvekre, District Tumkur, Karnataka, India.

The local stakeholders appreciated the CDM initiative and the fact that it would reduce GHGs emissions into the atmosphere and conserve energy and natural resources. The stakeholders viewed MCL as a responsible company contributing to local and global environmental through such initiatives. Overall there was unanimous agreement that the project activity was really a proactive initiative by the project party, which contributes, to the sustainable development.

G.2. Summary of the comments received:

>>

Stakeholder concerns / question / comment	Answer / clarifications
Environment/safety	
Will the quality of slag cement be the same as Portland cement?	The slag cement quality conforms to IS 455:1989. The properties of slag cement are similar to OPC.
Where are you sourcing the slag?	JSW Steel Limited, Visvesvarya Iron & Steel Ltd and Kalyani Steels Ltd.
Which cement, amogst PSC and OPC, is better with respect to environment?	PSC uses lesser quantity of clinker in comparison to OPC. Thus reduces associated direct and indirect GHGs emissions into the atmosphere.
Does the project activity require additional water?	There is no additional requirement of water for Slag cement preparation. Slag cement preparation is a dry process. Water

Stakeholder concerns / question / comment	**Answer / clarifications**
	is required only as cooling water. During manufacture, slag cement consumes less water than the equivalent amount of OPC cement.
Do you generate any solid waste due to project activity?	In projects activity there is no additional solid waste. Infact, we are utilizing solid waste to prepare cement
What care workers have to observe while handling slag?	Workers would have to wear personal protective equipment and follow strictly the safety and occupational health instructions
Economic	
Have you done any additional investment for the project activity?	We have invested in R & D, promotional activities and marketing activities. The increasing percentage of slag in PSC also requires additional investment on liners.
Social	
Does slag cement bring about change in the quality of concrete?	Slag cement improves certain properties of concrete, strength and durability of hardened concrete. Slag cement is a hydraulic binder that, like portland cement, reacts with water to form cementitious material.
Have you taken employees' view on this project activity?	We have encouraged the participation of the employees in expressing their views, and have taken views from the representative.

G.3. Report on how due account was taken of any comments received:

>> The stakeholders were provided clarifications on the issues raised as above to their satisfaction. None of the concerns expressed by the stakeholders required an action to be taken by the MCL during the project operation and at any other stage.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

Organization:	Mysore Cements Limted
Street/P.O.Box:	Regd Office; 1st floor, Industry House, 45 Race Course Road
Building:	Industry House
City:	Bangalore
State/Region:	Karnataka
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E-Mail:	mycembg@vsnl.com; myscemam@sacharnet.in
URL:	
Represented by:	Executive Vice President
Title:	Mr
Salutation:	
Last Name:	Kumar
Middle Name:	K
First Name:	B
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Personal E-Mail:	myscemam@sacharnet.in

Annex 2

INFORMATION REGARDING PUBLIC FUNDING

No official Development assignment is used in this project activity.

Annex 3

BASELINE INFORMATION

		2001	2002	2003	2004
Emission of CO2 per tonne of clinker		Project	Project	Project	Project
Emission per tonee of clinker due to calcination of $CaCO_3$ and $MgCO_3$ in year y					
Quantity of raw mix	Tonne	250397	348090	302753	287134
Quantity of clinker produced	Tonne	160514	226134	205957	195332
CaO content (%) of raw mix	%	0	0	0	0
MgO content (%) of raw mix	%	0	0	0	0
CaO content (%) of clinker	%	63.28	63.78	63.81	63.44
MgO content (%) of clinker	%	3.92	3.44	3.63	3.8
Emission from the calcination of limestones	tCO_2/t clinker	0.5395544	0.5382378	0.5405481	0.5395
Emission per tonne of clinker due to combustion of fossil fuel for clinker production					
Quantity of coal consumed in Kcal	kcal	1.70912E+11	2.16455E+11	1.85873E+11	1.80127E+11
Quantity of coal consumed in TJ	TJ	715.5764131	906.2558162	778.2130764	754.1548025
Carbon emission factor	t CO_2/TJ	96.06666667	96.06666667	96.06666667	96.06666667
Emission factor for coal consumed for clinker production	tCO_2/t clinker	0.428268193	0.384997282	0.362990023	0.370902556
Grid electricty emission for clinker production per tonne of clinker					
Grid electricty for clinker production	MWh	137.601	186.806	345.808	714.02
Grid emission factor	t CO_2/MWh	0.996	0.996	0.996	0.996
Grid electricty emissions for tonne of clinker production	tCO_2/t clinker	0.000853823	0.000822781	0.001672314	0.003640796
Self generating emission for clinker production per tonne of clinker					
self generating electricty for clinker production	MWh	12164.84	16834.532	13863.54	15651.967
DG set emission factor	t CO_2/MWh	0.809656923	0.820453834	0.784569428	0.800732972
Self electricty emissions for tonne of clinker production	tCO_2/t clinker	0.061361295	0.061078636	0.052811556	0.06416279
Emission of CO2 per tonne of clinker production	tCO_2/t clinker	1.030037712	0.9851365	0.958021993	0.978206141
Electricty emission for BC grinding and preparation of additives					
Grid electricity emission for BC grinding in a year y					
Grid electricity emission for BC grinding	tCO_2/t of BC	0	0	0	0
Self electricity emission for BC grinding in a year y					
Quantity of BC produced	tonne	245967	354345	374138.39	379136.01
Self generating electricty for grinding BC	MWh	18005.227	19049.458	20525.134	22371.917
DG set emission factor	t CO_2/MWh	0.809656923	0.820453834	0.784569428	0.800732972
Self electricty emissions for tonne of grinding	tCO_2/t of BC	0.059268344	0.044107299	0.043041273	0.047249354
Grid electricty emission for additive preparation in year y					
Grid electricty emission for additive preparation in year y	tCO_2/t of BC	0	0	0	0
Self electricty emission for additive preparation in year y					
Self electricty emission for additive preparation in year y	tCO_2/t of BC	0	0	0	0
Electricty emission for BC grinding and preparation of additives	tCO_2/t of BC	0.059268344	0.044107299	0.043041273	0.047249354
$B_{Blend,y}$ = Baseline benchmark of share of clinker per tonne of BC	% of clinker	0.601576	0.593914	0.586252	0.57859
$P_{Blend,y}$ = Project activity of share of clinker per tonne of BC	% of clinker	0.51319	0.49785	0.51913	0.50034
Baseline Emissions C	tCO_2/t of BC	0.640430213	0.632715554	0.625000895	0.617286237
Project Emissions C	tCO_2/t of BC	0.587873397	0.534557505	0.54037923	0.536685015

Operating Margin

OPERATING MARGIN - YEAR 2002 - 2003

Fuel	Units	Consumption*	Mass Conversion Factor ***	Density 10^3 MT	Emission factor ($tCO_2/10^3$ tonnes)* NG =TCO_2/M Cu.m)	Gross Emissions (tCO_2)	Gross Electricity Generation* (GWh)	Auxiliary Consumption** (%)	Net supply to grid (GWh)
Steam Stations									
Coal	000 MT	65997	1	65997	1644.0	108498729	92053.1	8.47	84256.20
Furnace Oil	KL	115914	0.93	107.8	3439.4	370772			
Light Diesel Oil/HSD	KL	8407	0.82	6.89374	2966.5	20450			
LSHS/HHS	KL	6093	0.82	4.99626	3230.7	16142			
Lignite	000 MT	17738	1	17738	1115.3	19782388			
Gas Stations									
Natural Gas	M Cu M	3130	1	3130	1931.4	6045140	13950.1	2.25	13636.22
HSD	KL	275122	0.82	225.6	2996.2	675940			
Naphtha	KL	485496	0.76	368.977	3267.7	1205716			
Diesel Stations									
LSHS	KL	0	0.82	0	3230.9	0	4379.4	1.61	4308.89
Diesel	KL	865938	0.82	710.1	2996.3	2127603			
						138742881			**102201.32**

Source of data: **Simple OM = 1357.54 tCO_2/GWh**

* Table 6.1, CEA General Review

** Table 5.6, CEA General review

OPERATING MARGIN - YEAR 2003 - 2004

Fuel	Units	Consumption*	Mass Conversion Factor ***	Density 10^3 MT	Emission factor ($tCO_2/10^3$ tonnes)* NG =TCO_2/M Cu.m)	Gross Emissions (tCO_2)	Gross Electricity Generation* (GWh)	Auxiliary Consumption** (%)	Net supply to grid (GWh)
Steam stations									
Coal	000 MT	52985	1	52985	1506	79776792	98434.61	8.46	90107.04
Furnace Oil	KL	56489	0.93	52.53477	3324	174609			
Light Diesel Oil/HSD	KL	33031	0.82	27.08542	3131	84812			
LSHS/HHS	KL	5310	0.82	4.3542	3163	13770			
Lignite	000 MT	20755	1	20755	1136	23586614			
Gas Stations									
Natural Gas	M Cu M	2010	1	2010	1931	3882023	14214.02	2.83	13811.76
HSD	KL	226981	0.82	186.1244	3127	582005			
Naphtha	KL	719694	0.76	546.9674	3268	1787340			
Diesel Stations									
LSHS	KL	647451	0.82	530.9098	3163	1679123	3294.75	1.74	3237.42
Diesel	KL	14903	0.82	12.22046	3127	38215			
Total						**111605302**			**107156.23**

Source of data: **Simple OM = 1041.52 tCO_2/GWh**

* Table 6.1, CEA General Review

** Table 5.5, CEA General review

OPERATING MARGIN - YEAR 2004 - 2005									
Fuel	Units	Consumption *	Mass Conversion Factor ***	Density 10^3 MT	Emission factor ($tCO_2/10^3$ tonnes)* NG =TCO_2/M Cu.m)	Gross Emissions (tCO_2)	Gross Electricity Generation* (GWh)	Auxiliary Consumption** (%)	Net supply to grid (GWh)
Steam Stations									
Coal	000 MT	53144	1	53144.0	1480.03	78654658.1			
Furnace Oil	KL	45848	0.93	42.6	3345.49	142647.2			
Light Diesel Oil/HSD	KL	24330	0.82	20.0	3121.54	62276.5			
LSHS/HHS	KL	2612	0.82	2.1	3199.72	6853.3			
Lignite	000 MT	22121	1	22121.0	1131.03	25019574.3	99009.99	8.37	90722.854
Gas stations									
Natural Gas	M Cu M	2203	1	2203.0	1931.35	4254774.4			
HSD	KL	81254	0.82	66.6	3152.75	210062.5			
Naphtha	KL	289451	0.76	220.0	3267.73	718843.4	12428.43	3.39	12007.106
Diesel Stations									
LSHS	KL	465220	0.82	381.5	3199.87	1220689.4			
Diesel	KL	63039	0.82	51.7	3152.90	162979.8	2433.93	2.91	2363.1026
Total						**110453358.9**			**105093.06**
							Simple OM =		**1051.0052**

Source

* Table 6.1, CEA General Review 2004 - 2005

** Table 5.5, CEA General Review 2004 - 2005

Combine Margin

	t CO2e/GWh	t CO2e/MWh
Operating Margin	1147	1.147
Build Margin	845	0.845
CM	996	0.996

Build Margin

Name of the plant	State	Date of Addition to Grid*	Installed Capacity* (MW)	PLF**	Gross Genearation (GWh)	Auxillary Consumption* *** (%)	Net supply to grid (GWh)	Emissin factor (tCO_2/GWh)	Total tCO_2
Hydro									
Kalindi Nagjhari	Karnataka	2004 - 05	45	0.30743266	121.1899545	0.4	120.705195	0	0
Sharavathy	Karnataka	2004-05	115.2	0.30743266	310.2462835	1.3	306.213082	0	0
Srisailam LBPH (Unit6)	AP	4-Sep-04	150	0.175536493	230.6549519	0.45	229.617005	0	0
Almatti Dam	Karnataka	26-Mar-04	15	0.30743266	40.3966515	1.3	39.871495	0	0
Sirsailam Left bank(5)	AP	28-Mar-03	150	0.175536493	230.6549519	0.45	229.617005	0	0
Sri Sailam LBPH	AP	26-Nov-02	150	0.175536493	230.6549519	0.45	229.617005	0	0
Sirsailam Left bank(2,3)	AP	12-Nov-01,29-	300	0.175536493	461.3099039	0.45	459.234009	0	0
Sirsailam Left bank(1)	AP	30-Mar-01	150	0.175536493	230.6549519	0.45	229.617005	0	0
Sharavathy Tail Race (2,3,4)	Karnataka	15-May-01,25-	180	0.30743266	484.759818	1.3	478.45794	0	0
Madhva Mantri	Karnataka	Mar-02	3	0.30743266	8.079330299	1.3	7.97429901	0	0
Madhva Mantri	Karnataka	Mar-02	6.6	0.30743266	17.77452666	1.3	17.5434578	0	0
Parsons Valley	TN	Mar-00	30	0.252768216	66.42748704	0.44	66.1352061	0	0
Singur Unit 1&2	AP	Dec-99	15	0.175536493	23.06549519	0.45	22.9617005	0	0
Kalinadi II	Karnataka	Aug-99	40	0.30743266	107.724404	1.3	106.323987	0	0
Kakkad	Kerala	Jul-99	50	0.51037047	223.542266	0.4	222.648097	0	0
Kadra	Karnataka	Jan-99	100	0.30743266	269.31101	1.3	265.809967	0	0
Kodasalli	Karnataka	Jun-98	80	0.30743266	215.448808	1.3	212.647973	0	0
Steam									
Ramagundam	AP	31-Aug-04	250	0.903177788	1977.959356	9.09	1798.16285	1145.10	2059073.497
Neyveli FST	TN	22-Jul-03	210	0.757207734	1392.959348	8.63	1272.74696	1145.10	1595075.593
Simadhri	AP	24-Aug-02	500	0.903177788	3955.918713	9.09	3596.3257	1145.10	4529916.394
Raichur	Karnataka	11-Dec-02	210	0.837865231	1541.336879	8.42	1411.55631	1145.10	1764982.474
Neyvelli TPS (1,2)	TN	21-Oct-02	210	0.757207734	1392.959348	8.63	1272.74696	1145.10	1595075.593
Neyvelli TPS (Zero unit)	TN	11-Oct-02	250	0.757207734	1658.284938	8.63	1515.17495	1145.10	1898899.515
Simhadri TPS	AP	22-Feb-02	500	0.903177788	3955.918713	9.09	3596.3257	1145.10	4529916.394
Raichur TPS-III	Karnataka	22-Jul-99	210	0.837865231	1541.336879	8.42	1411.55631	1145.10	1764982.474
Torangallu	Karnataka	16-May-99	130	0.837865231	954.1609249	8.42	873.820575	1145.10	1092608.198
Diesel									
Kasargode DG	Kerala	Mar-02	21.84	0.138914708	26.57693964	2.65	25.8726507	590.53	15694.45807
Belgaum DG	Kar	Mar-02	81.3	0.138914708	98.93338793	2.65	96.3116531	590.53	58423.05135
Samayanallue DGPP	TN	22-Sep-01	106	0.428241642	397.6480591	2.87	386.23556	590.53	234822.7778
LVS DGPP***	AP	18-Oct-01	36.8	0	0	0	0	590.53	0
Sampalpatti DG (1-7)	TN	1-Mar-01	105.66	0.428241642	396.3725842	2.87	384.996691	590.53	234069.5727
Kozikode DG	Kerala	6-Jun-99	135	0.138914708	164.2805335	3.66	158.267866	590.53	97012.44689
Wind									
Private	AP	31-Mar-04	6.2	0.181194697	9.841046397	0	9.8410464	0.00	0
Private	TN	31-Mar-04	504.06	0.257077117	1135.140874	0	1135.14087	0.00	0
State	TN	31-Mar-04	0.07	0.257077117	0.157639688	0	0.15763969	0.00	0
State	Karnataka	31-Mar-04	2.02	0.202472537	3.582792029	0	3.58279203	0.00	0
Private	Karnataka	31-Mar-04	138.58	0.202472537	245.7937225	0	245.793722	0.00	0
Wind (state)	AP	1-Jun-01	2.35	0.181194697	3.730074038	0	3.73007404	0.00	0
Wind (pvt)	AP	1-Jun-01	0.69	0.181194697	1.095213228	0	1.09521323	0.00	0
Wind (pvt)	TN	1-Jun-01	69.38	0.257077117	156.2434509	0	156.243451	0.00	0
Wind (pvt)	Kar	1-Jun-01	30.78	0.202472537	54.59323696	0	54.593237	0.00	0
Gas									
Karrupur CCPP GT	TN (pvt)	19-Feb-05	70	0.34062609	208.8719182	5.28	197.843481	431.87	90204.8983
Kuttalam CCPPGT	TN	26-Nov-03	63	0.34062609	187.9847264	5.28	178.059133	431.87	81184.40847
Kuttalam CCPP	TN	24-Mar-04	37	0.34062609	110.4037282	5.28	104.574411	431.87	47679.73196
Valthur GTPP	TN	24-Dec-02	60	0.34062609	179.0330728	5.28	169.580127	431.87	77318.48426
Valthur (ST)GTPP	TN	13-Mar-03	34	0.34062609	101.4520746	5.28	96.095405	431.87	43813.80775
Peddapuram CCGT	AP	12-Sep-02	78	0.848661785	579.8736246	2.57	564.970872	431.87	250428.3093
Peddapuram CCGT	AP	26-Jan-02	142	0.848661785	1055.667368	2.57	1028.53672	431.87	455907.9477
Pillaiperumalanallur CCGT (st U-1)	TN	5-Apr-01	105.5	0.34062609	314.7998196	5.28	298.178389	431.87	135951.6682
Tanir Bavi CCGT (Unit1,2,3,4)	Karanataka	8-May-01	170	0.343192196	511.0818182	4.71	487.009865	431.87	220719.3951
Tanir Bavi CCGT (St-10	Karanataka	21-Nov-01	50	0.343192196	150.3181818	4.71	143.238195	431.87	64917.46914
Kovikalappal GT (Unit-ST-1)	TN	30-Mar-01	38	0.34062609	113.3876127	5.28	107.400747	431.87	48968.37337
Kayam kulam CCGT	Kerala CS	30-Jan-00	119.4	0.202785388	212.10216	4.06	203.490812	431.87	91599.93328
Karaikal ST***	Pondicherry	2-Jul-99	9.6	0	0	0	0	431.87	0
Cochin CCGT	Kerala	6-Jun-99	135	0.077999528	92.24224138	5.21	87.4364206	431.87	39836.3843
Nuclear									
Kaiga NPP	Karnataka CS	2-Dec-99	220	0.606260659	1168.385542	11.34	1035.89062	0.00	0
					29322.32429		27357.5784		23119083.25

Annex 4

MONITORING PLAN

As in section D.

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