Monitoring Report

Mysore Cements Limited Portland Slag Cement project

for the period

(January 1, 2001 to December 31, 2006)

UNFCCC Reference No: 0711

Version 04
May 20, 2008

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SECTION 0

Project Title: *Mysore Cements Limited Portland Slag Cement Project*

UNFCCC Reference no*:* *0711*

Monitoring period*:* *January 1, 2001 to December 31, 2006*

Document Version: **04**

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SECTION 1

1.1 Introduction

Mysore Cements Limited is an indirect subsidiary of the Heidelberg Cement Group, one of the largest cement manufacturers in the world. The company was earlier one of the leading companies of the SK Birla group and had established its first unit at Ammasandra in 1962. The plant manufactures 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.

1.2 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.

1.3 Project Location

The existing "slag and clinker grinding - mixing unit" is located at Ammsandra, Taluka: Turvekre, District Tumkur, state: Karnataka, India. The site is at a distance of 46 kms from Tumkur, 125 kms from Bangalore City by road. The nearest railway station is Ammasandra, while nearest airport / airstrip is Bangalore.

1.4 Current status of the project activity

The project activity is registered with UNFCCC as CDM activity under ***"Sector 4 – Manufacturing industries"***. The UNFCCC reference number is 0711

1.5 Baseline methodology

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

SECTION 2

2 Monitoring

2.1 Monitoring methodology

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

2.2 Monitoring period

The monitoring of parameters is done for the baseline emissions, project emissions, and leakage calculations. Monitoring period for the project activity is chosen from 1st January 2001 to 31st December 2006. Parameters monitored during the period and their recording frequency is given in the ensuing paragraph. Data of all the relevant years have been archived for the verification purpose, and shall be kept for a minimum of two years after the crediting period.

2.3 Monitoring parameters

2.3.1 Data monitored for the Baseline Emission Calculations

ID No	Data variable	Data unit	Recording frequency	Reference
1.1	$InCaO_{BSL}$	%	Daily	Appendix-I
1.2	$OutCaO_{BSL}$	%	Daily	Appendix-I
1.3	$InMgO_{BSL}$	%	Daily	Appendix-I
1.4	$OutMgO_{BSL}$	%	Daily	Appendix-I
1.5	Quantity of clinker raw material	Kilo tonnes	Annually	Appendix-I
1.6	$CLNK_{BSL}$	Kilo tones of clinker	Annually	Appendix-I
1.7	$FF_{i\ ,BSL}$	Tonnes of	Annually	Appendix-I

		fuel i		
1.8	EFF_i	tCO2/tonne of fuel i	Annually	Appendix-I
1.9	$BELE_{grid\_CLNK,BSL}$	MWh	Monthly	Appendix-I
1.10	EF_{grid_BSL}	t CO2/MWh	Annually	Appendix-I
1.11	$BELE_{sg\_CLNK,BSL}$	MWh	Monthly	Appendix-I
1.12	EF_{sg_BSL}	t CO2/MWh	Monthly	Appendix-I
1.13	ADD_{BSL}Quantity of additives	Kilo tonnes	Monthly	Appendix-I
1.14	$BELE_{grid\_BC,BSL}$	MWh	Monthly	Appendix-I
1.15	$BELE_{sg\_BC,BSL}$	MWh	Monthly	Appendix-I
1.16	$BELE_{grid\_ADD}$	MWh	Monthly	Appendix-I
1.17	$BELE_{sg\_ADD,BSL}$	MWh	Monthly	Appendix-I
1.18	$F_{i,j,BSL}$	Tonnes of fuel i	Monthly	Appendix-I
1.19	$COEF_{i,j\ BSL}$	tCO_2/tonne of fuel i	Annually	Appendix-I
1.20	$GEN_{j,BSL}$	MWh	Annually	Appendix-I
1.21	$BE_{calcin,BSL}$	t CO_2/tonne clinker	Annually	Appendix-I
1.22	$BE_{fossil\_fuel,BSL}$	t CO_2/tonne clinker	Annually	Appendix-I
1.23	$BE_{ele\_grid\_CLNK,BSL}$	t CO_2/tonne clinker	Annually	Appendix-I
1.24	$BE_{ele\_sg\_CLNK,BSL}$	t CO_2/tonne clinker	Annually	Appendix-I
1.25	$BE_{ele\_grid\_BC,BSL}$	t CO_2/tonne blended cement	Annually	Appendix-I
1.26	$BE_{ele\_sg\_BC,BSL}$	t CO_2/tonne blended cement	Annually	Appendix-I
1.27	$BE_{ele\_grid\_ADD,BSL}$	t CO_2/tonne blended cement	Annually	Appendix-I
1.28	$BE_{ele\_sg\_ADD,BSL}$	t CO_2/tonne blended	Annually	Appendix-I

		cement		
1.29	$B_{blend,y}$	Tonne of additives/tonnes of blended cement	Annually	Appendix-I

2.3.2 Data monitored for the Project Emission Calculations

ID No	Data variable	Data unit	Recording frequency	Reference
2.1	$InCaO_Y$	%	Daily	Appendix-I
2.2	$OutCaO_Y$	%	Daily	Appendix-I
2.3	$InMgO_Y$	%	Daily	Appendix-I
2.4	$OutMgO_Y$	%	Daily	Appendix-I
2.5	Quantity of clinker raw material	Kilo tonnes	Annually	Appendix-I
2.6	$CLNK_Y$	Kilo tones of clinker	Annually	Appendix-I
2.7	$FF_{i\_,Y}$	Tonnes of fuel i	Annually	Appendix-I
2.8	EFF_i	tCO2/tonne of fuel i	Annually	Appendix-I
2.9	$PELE_{grid\_CLNK,Y}$	MWh	Monthly	Appendix-I
2.10	EF_{grid_BSL}	t CO2/MWh	Annually	Appendix-I
2.11	$PELE_{sg\_CLNK,Y}$	MWh	Monthly	Appendix-I
2.12	EF_{sg_Y}	t CO2/MWh	Monthly	Appendix-I
2.13	ADD_YQuantity of additives	Kilo tonnes	Monthly	Appendix-I
2.14	$PELE_{grid\_BC,Y}$	MWh	Monthly	Appendix-I
2.15	$PELE_{sg\_BC,Y}$	MWh	Monthly	Appendix-I
2.16	$PELE_{grid\_ADD}$	MWh	Monthly	Appendix-I
2.17	$PELE_{sg\_ADD,Y}$	MWh	Monthly	Appendix-I

2.18	$F_{i,j,Y}$	Tonnes of fuel i	Monthly	Appendix-I
2.19	$COEF_{i,j\ Y}$	tCO_2/tonne of fuel i	Annually	Appendix-I
2.20	$GEN_{j,Y}$	MWh	Annually	Appendix-I
2.21	$PE_{calcin,Y}$	t CO_2/tonne clinker	Annually	Appendix-I
2.22	$PE_{fossil\_fuel,Y}$	t CO_2/tonne clinker	Annually	Appendix-I
2.23	$PE_{ele\_grid\_CLNK,Y}$	t CO_2/tonne clinker	Annually	Appendix-I
2.24	$PE_{ele\_sg\_CLNK,Y}$	t CO_2/tonne clinker	Annually	Appendix-I
2.25	$PE_{ele\_grid\_BC,Y}$	t CO_2/tonne blended cement	Annually	Appendix-I
2.26	$PE_{ele\_sg\_BC,Y}$	t CO_2/tonne blended cement	Annually	Appendix-I
2.27	$PE_{ele\_grid\_ADD,Y}$	t CO_2/tonne blended cement	Annually	Appendix-I
2.28	$PE_{ele\_sg\_ADD,Y}$	t CO_2/tonne blended cement	Annually	Appendix-I
2.29	$B_{blend,y}$	Tonne of additives/tonne of blended cement	Annually	Appendix-I

2.3.3 Data to be monitored for Leakage Calculations

ID No	Data variable	Data unit	Recording frequency	Reference
3.1	TF_{cons}	kg of fuel/kilometre	Annually	Appendix-I
3.2	D_{add_source}	km	Per trip	Appendix-I
3.3	TEF	kg CO_2/kg of fuel	Annually	Appendix-I
3.4	Q_{add}	Tonnes of additive /vehicle	Per trip	Appendix-I

3.5	$ELE_{conveyor\_ADD}$	MWh	Monthly	Appendix-I
3.6	EF_{grid}	Tonnes of CO_2/MWh	Annually	Appendix-I
3.7	α_y	Tonnes of additive	Annually	Appendix-I

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

The plant is operated by Company's operating personnel. The operating personnel follows the standard operating procedures (SOP) delineated for each department. The DGM (Finance) has been assigned the responsibility of the project management as also for monitoring, measurement and reporting. The deputy general managers of the relevant departments (stores, laboratory, costing and sales) are assigned with the responsibilities of archiving the respective data for pre-determined monitoring parameters as given in the monitoring plan with actual readings being taken by the Shift In-charges and Engineers. The reporting structure for the CDM project activity is attached separately as Annex I.

The personnel are adequately trained and highly competent enough to carry out the necessary work.

The QA & QC procedures are practiced and implemented in order to:

1. Secure a good consistency through planning to implementation of this CDM project and,

2. Stipulate who has responsibility for what and,

2. Avoid any misunderstanding between people and organization involved.

3. Calibration of the relevant instruments and meters

ID number	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1.1-1.31 & 2.1-2.31	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 ***purchase (stores)*** and ***costing*** department.

Calibration/Maintenance of Measuring Instruments and meters

Monitoring of parameters, which involve measurements, was done with necessary equipments according to the pre-determined intervals mentioned in the monitoring plan as per the monitoring methodology adopted for the project activity. The calibration of the monitoring equipments is done regularly. The calibration certificates for the relevant instruments and meters are available at the plant for the verification. Identified Energy Meters, which directly register clinker production and cement grinding both from BESCOM and DG will be calibrated once in every two years. Meter calibration will be done by External authorized agencies. If any Meter cannot be calibrated to its tolerance, it will be replaced & calibrated at the earliest by the authorized external agency. ***Meter location chart*** giving the details and location of each meter is provided separately as Annex II. Detailed operating, inspection and calibration procedure of weighbridge is attached as Annex III.

(Note: Meters which are used for monitoring the parameters of the current CDM project are highlighted in the chart)

2.3.5 Environmental Management Plan

The plant possesses the valid consent to operate from the Karnataka State pollution Control Board. Internal Environmental Audit Reports are prepared regularly and submitted to the State pollution control board and are available at the project site for verification.

The project executes the pollution control measures as part of the pollution control plan (*Environmental Management Plan). Environmental monitoring is carried out regularly in the plant as per the predetermined frequency for all the concerned parameters. There are four ambient air monitoring stations at the cement manufacturing unit. The parameters like NO_x, CO and HC are being monitored by a MoEF approved external agency once in three months. Installations of Bag filters replacing the Electrostatic Precipitators have been implemented in the year 2006, as a pollution control measure, in order to control and maintain the emission levels below the specified standard limits

(Note: The EMP is attached separately as Annex IV and is available for verification)*

SECTION 3

GHG Emission Reductions

The project activity entails the reduction of clinker content of Portland Slag Cement (PSC) production by increasing the percentage of slag and thereby replacing the equivalent amount of clinker at MCL's cement manufacturing units at Ammasandra, Karnataka. 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. The formula for calculations of emission reductions is as below:

$$\mathbf{ER_{y} = \{ [BE_{BC,y} – PE_{BC,y}] * BC_{y} + L_{y} \} * (1 – \alpha_{y})}$$

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)

α_y = amount (tonnes of) additive used in year y/ total additional additives used in year y

Year wise Emission reductions achieved during the monitoring period (January 2001 to December 2006) are presented in the following Table 3.1. The detailed calculations, including those of the baseline emissions, project emissions, and leakages are given at the Appendix I

Table 3.1: **Emission Reductions during the period January, 2001 to December 2006**

Year	**Emission Reductions (tCO2e)**
2001	**12420.98**
2002	**35252.92**
2003	**32520.74**
2004	**30787.42**
2005	**20142.70**
2006	**13333.65**
TOTAL EMISSION REDUCTIONS **(tCO2e)**	**144458.41**
	144458

SECTION 4

APPENDIX-I

Baseline emissions

$$BE_{BC,y} = [BE_{clinker} * B_{Blend,y}] + BE_{ele\_ADD\_BC} \text{ -----------------(1)}$$

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)

Table 4.1 (Baseline emissions for the period January 2001 to December 2006)

Year	**$BE_{clinker}$** (tCO_2/tonne of clinker)	**B_{Blend}** (tonne of clinker/tonne of BC)	**$BE_{elec\_sg\_BC}$** self generated electricity emissions for BC grinding (tCO_2/tonne of BC)	**$BE_{BC,y}$** (tCO_2/tonne BC)
2001	1.0362	0.601576	0.06182	0.650494
2002	0.9873	0.593914	0.04467	0.642659
2003	0.9605	0.586252	0.04441	0.634824
2004	0.9821	0.57859	0.04871	0.626989
2005	0.9734	0.570928	0.05460	0.619154
2006	1.0133	0.563266	0.05446	0.611319

Project emissions

$$PE_{BC,y} = [PE_{clinker,y} * P_{Blend,y}] + PE_{ele\_ADD\_BC,y} \text{ -------------------- (2)}$$

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)

$$PE_{clinker,y} = PE_{calcin,y} + PE_{fossil\_fuel,}y + PE_{ele\_grid\_CLNK,y} + PE_{ele\_sg\_CLNK,y} \text{ -------- (2.1)}$$

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)

$$PE_{calcin,y}=0.785*(OutCaOy - InCaOy)+1.092*(OutMgOy - InMgOy)/[CLNKy* 1000] \text{ ---(2.1.1)}$$

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)

Table 4.2 (Project emissions from the calcinations of limestone for the period January 2001 to December 2006)

Year	(CaO content % of the raw material)-year average	(CaO content % of the clinker)-year average	(MgO content % of the raw material)-year average	(MgO content % of the clinker)	**CLKN** (Annual clinker produced, Kilotones)	**$PE_{calcin,y}$** (Annual Emissions from the calcinations of limestone ,tCO_2/tonne clinker)
2001	0	63.28	0	3.91	160.514	0.5394452
2002	0	63.77	0	3.54	226.134	0.5392513
2003	0	63.82	0	3.63	205.957	0.5406266
2004	0	63.45	0	3.79	195.332	0.5394693
2005	0	62.96	0	4.03	192.772	0.5382436
2006	0	62.38	0	4.70	216.061	0.5410070

$PE_{fossil\_fuel, y}$ = [$\sum FF_{i\_,y}$ * EFF_i] /$CLNK_{,y}$ * 1000 ------------(2.1.2)

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)

Table 4.3 (Project emissions from fossil fuel consumption for the clinker production during the period January 2001 to December 2006)

Year	**Quantity of coal consumed annually FFi** (MT)	**PE_{fossil_fuel}** (tCO_2/tonne of clinker)
2001	33767	0.43381
2002	33197	0.38616
2003	29828	0.36354
2004	42649	0.37306
2005	44317	0.36755
2006	49521	0.40101

$$\mathbf{PE_{ele\_grid\_CLNK,y} = [\ PELE_{grid\_CLNK,y} * EF_{grid\_y}] / [CLNK_y * 1000]} \text{ --------(2.1.3)}$$

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)

Table 4.4: Project emissions from grid electricity consumption for the clinker production

Year	**$PELE_{grid\_CLNK}$** (Annual grid electricity for clinker production , MWh)	**EF_{grid}** Grid emission factor (t CO_2/MWh)	**$PE_{ele\_grid\_CLNK}$** Annual grid electricity emissions for clinker production per tonne of clinker (tCO2/tclinker)
2001	137.601	0.996	0.0008538
2002	186.806	0.996	0.0008196
2003	345.808	0.996	0.0016723
2004	714.020	0.996	0.0036408
2005	1044.265	0.996	0.0053954
2006	1375.434	0.996	0.0063405

*(*Note – Detailed calculation of Grid Emission factor for years 2001-2006 is given as ANNEX V)*

$$PE_{elec\_sg\_CLNK,y} = [PELE_{sg\_CLNK,y} * EF_{sg\_y}] / [CLNK_y * 1000] \text{ --------------(2.1.4)}$$

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)

Table 4.5: Project emissions from self generated electricity consumption for clinker production

Year	**$PELE_{sg\_CLNK}$** (self generated electricity for clinker production , MWh)	**EF_{sg}** Self generated electricity emission factor (t CO_2/MWh)	**$PE_{elec\_sg\_CLNK}$** Annual emissions from self generated electricity per tonne of clinker (tCO2e/tclinker)
2001	12164.840	0.8188	0.06205
2002	16834.532	0.8200	0.06105
2003	13863.540	0.8118	0.05464
2004	15651.967	0.8231	0.06596
2005	14691.282	0.8159	0.06218
2006	17654.842	0.7947	0.06493

Table 4.6: Project emissions from clinker production

Year	**$PE_{clinker}$** (tCO2/tclinker)
2001	1.0362
2002	0.9873
2003	0.9605
2004	0.9821
2005	0.9734

2006	1.0133

$$PE_{ele\_ADD\_BC,y} = PE_{ele\_grid\_BC,y} + PE_{ele\_sg\_BC,y} + PE_{ele\_grid\_ADD,y} + PE_{ele\_sg\_ADD,y} \text{----------(2.2)}$$

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)

$$PE_{ele\_grid\_BC,y} = [\ PELE_{grid\_BC,}y * EF_{grid\_BSL,y}] / [BC_y * 1000] \text{----------------------(2.2.1)}$$

Where:

$PELE_{grid\_BC,y}$ = 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)

Table 4.7: Project emissions from grid electricity consumption for the blended cement production

Year	$PELE_{grid\_BC}$ (MWh)	EF_{grid} (t CO_2/MWh)	**BC** Annual production of BC in year y (tonnes of BC)	$PE_{ele\_grid\_BC}$ Grid electricity emissions for BC grinding (tCO_2/tonne of BC)
2001	0	0.996	245967	0
2002	0	0.996	354345	0
2003	0	0.996	374138	0
2004	0	0.996	379126	0
2005	0	0.996	333000	0
2006	0	0.996	336559	0

$$\mathbf{PE_{elec\_sg\_BC,y} = [PELE_{sg\_BC,y} * EF_{sg\_y}] / [BC_y * 1000]}$$ ------------------(2.2.2)

Where:

$PELE_{sg\_BC,y}$ = 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 (kilo tonnes of BC)

Table 4.8: Project emissions from self generated electricity consumption for the grinding of blended cement

Year	**$PELE_{sg\_BC}$** (MWh)	**EF_{sg}** (t CO_2/MWh)	**BC** Annual production of BC in year y (tonnes of BC)	**$PE_{elec\_sg\_BC}$** self generated electricity emissions for BC grinding (tCO_2/tonne of BC)
2001	18571.811	0.8188	245967	0.06182
2002	19302.201	0.8200	354345	0.04467
2003	20466.54	0.8118	374138	0.04441
2004	22434.504	0.8231	379126	0.04871
2005	22283.464	0.8159	333000	0.05460
2006	23066.683	0.7947	336559	0.05446

$$\mathbf{PE_{ele\_grid\_ADD} = [PELE_{grid\_ADD} * EF_{grid\_y}] / [BC_y * 1000]}$$ -------------(2.2.3)

Where:

$BELE_{grid\_ADD}$ = 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)

Table 4.9 (Project emissions from grid electricity consumption for the grinding of additives during the period January 1, 2001 to December 31, 2006)

Year	**$PELE_{grid\_ADD}$** (MWh)	**EF_{grid}** (t CO_2/MWh)	**BC** Annual production of BC in year y (tonnes of BC)	**$PE_{ele\_grid\_ADD}$** grid electricity emissions for BC grinding tCO_2/tonne of BC)
2001	0	0.996	245967	0
2002	0	0.996	354345	0
2003	0	0.996	374138	0
2004	0	0.996	379126	0
2005	0	0.996	333000	0
2006	0	0.996	336559	0

$$PE_{elec\_sg\_ADD,y} = [PELE_{sg\_ADD,y} * EF_{sg\_y}] / [BC_y * 1000] \text{ -----------(2.2.4)}$$

Where:

$PELE_{sg\_ADD,y}$ = 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)

Table 4.10: Project emissions from self generated electricity consumption for the grinding of additives

Year	**$PELE_{sg\_ADD}$** (MWh)	**EF_{sg}** (t CO_2/MWh)	**BC** Annual production of BC in year y (tonnes of BC)	**$PE_{elec\_sg\_ADD}$** grid electricity emissions for BC grinding tCO_2/tonne of BC)
2001	0	0.8188	245967	0
2002	0	0.8200	354345	0
2003	0	0.8118	374138	0
2004	0	0.8231	379126	0
2005	0	0.8159	333000	0

2006	0	0.7947	336559	0

****$PE_{elec\_sg\_ADD}$** is taken as zero because in the project activity, additives are grinded with the clinker*

Table 4.11: Project emissions from BC grinding and preparation of additives

Year	$PE_{ele\_ADD\_BC}$ (tCO_2/tonne of BC)
2001	0.06182
2002	0.04467
2003	0.04441
2004	0.04871
2005	0.05460
2006	0.05446

<u>Project emissions</u>

$$PE_{BC,y} = [PE_{clinker,y} * P_{Blend,y}] + PE_{ele\_ADD\_BC,y} \text{ ----------------------------(2)}$$

Table 4.12 (Project emissions per tonne of BC during the period January 1, 2001 to December 31, 2006)

Year	$PE_{clinker}$ (tCO_2/tonne of clinker)	P_{Blend} tonne of clinker / tonne of blended cement)	$PE_{ele\_ADD\_BC}$ (tCO_2/tonne BC)	PE_{BC} (tCO_2/tonne BC)
2001	1.0362	0.5132	0.06182	0.59356934
2002	0.9873	0.4978	0.04467	0.53618742
2003	0.9605	0.5191	0.04441	0.54302218
2004	0.9821	0.5003	0.04871	0.54009313
2005	0.9734	0.5136	0.05460	0.554495633
2006	1.0133	0.5064	0.05446	0.56756554

$^*P_{blend}$ is share of clinker per tonne of BC produced in year y (tonne of clinker / tonne of BC) and Pblend is calculated using following formulae

= clinker consumed in PSC / PSC production

Clinker consumed in PSC = PSC production- Gypsum consumption in PSC – Slag consumption in PSC

Leakages

$$\mathbf{L_{add\_trans} = [(TF_{cons} * D_{add\_source} * TEF) * 1/Q_{add} * 1/1000 + (ELE_{conveyor\_ADD} * EF_{grid}) * 1/ADD_Y] \text{—}(3.1)}$$

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

$$\mathbf{L_y = L_{add\_trans} * [A_{blend,y} - P_{blend,y}] * BC_y \text{ ----------------------}(3.2)}$$

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)

α_y = x tonnes of additives in year y / total additional additives used in year y

Another possible leakage is due to diversion of additives from existing uses. The project proponents (PPs) shall demonstrate that the additional amounts of additives used are surplus. If the PPs do not substantiate that the amount of additives, used in the project activity, are surplus, the project emission reductions are reduced by the factor α, α is defined as follows;

(α = tonnes of additive used in year y / total additional additives used in year y)

Table 4.13: Quantity of additives used

Year	Additive (tonnes)
2001	112517.60
2002	166109.85
2003	165425.12
2004	174515.29
2005	148614.57
2006	154850.80

Table 4.14: Transport related emissions per ton of additives

Year	TFcons	TEF	ELEconveyor_ADD	EFgrid	Dadd_source	Qadd	Add	Ladd_trans
2001	0.286	3.09	0	0.996	1400	17	112517.60	0.0727059
2002	0.286	3.09	0	0.996	1400	17	166109.85	0.0727059
2003	0.286	3.09	0	0.996	1400	17	165425.12	0.0727059
2004	0.286	3.09	0	0.996	1400	17	174515.49	0.0727059
2005	0.286	3.09	0	0.996	1400	17	148614.57	0.0727059
2006	0.286	3.09	0	0.996	1400	17	154850.80	0.0727059

Table 4.15: Leakage emissions due to transportation of additives

Year	Ablend	Pblend	BC (Production)	Ly
2001	0.398424	0.486813	245967	-1580.69
2002	0.406086	0.502149	354345	-2474.87
2003	0.413748	0.480873	374138	-1825.95
2004	0.42141	0.499670	379126	-2157.22
2005	0.429072	0.486429	333000	-1388.68
2006	0.436734	0.493628	336559	-1392.19

Emission Reductions during the period January 1, 2001 to December 31, 2006

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

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)

Table 4.16: Baseline emissions, Project emissions and Leakage emissions

Year	$BE_{BC,y}$ Baseline emissions per tonne of BC (t CO2/tonnes of BC)	PE_{BC} Project emissions per tonne of BC (tCO_2/tonne BC)	BC (tonnes of BC)	L_y (kilotonnes of CO_2)	α (tonnes of additive used in year y / total additional additives used in year y)
2001	0.650494	0.593567	245967	-1580.69	0
2002	0.642659	0.536187	354345	-2474.87	0
2003	0.634824	0.543022	374138	-1825.95	0
2004	0.626989	0.540093	379126	-2157.22	0
2005	0.619154	0.554496	333000	-1388.68	0
2006	0.611319	0.567565	336559	-1392.19	0

Table 4.15: Emission Reductions during the period January 1, 2001 to December 31, 2006

Year	$BE_{BC,y}$ Baseline emissions (tCO_{2e})	PE_{BC} Project emissions ($t\ CO_{2e}$)	L_y Leakage Emissions (tCO_{2e})	ER_y Emissions reductions (tCO_{2e})
2001	160000.13	145998.47	-1580.69	12420.98
2002	227723.13	189995.33	-2474.87	35252.92
2003	237511.92	203165.23	-1825.95	32520.74
2004	237707.99	204763.35	-2157.22	30787.42
2005	206178.43	184647.05	-1388.68	20142.70
2006	205745.07	191019.23	-1392.19	13333.65
TOTAL EMISION REDUCTIONS(tCO_{2e})				144458.41
				144458