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UNIDO Contract No: 05/036
UNIDO Project No: EG/CPR/99/G31
Agreeso No: 16000855

Final Report

Submitted to

United Nations Industrial Development Organization (UNIDO)

Contract Name:

Technical Renovation on Shaft Kiln Production Line for Energy Efficient at Huangshi Lufeng Cement Co., Ltd.

Project Name:

Energy Conservation and Greenhouse Gas Emissions Reduction in Chinese TVEs (Phase II)

Submitted by

Chaoyang Heavy Machinery Group Import and Export Ltd. Co.

Oct, 2006

CONTENTS

1. Introduction

This is the draft final report submitting to the Project Management Office (PMO) of the Chinese Ministry of Agriculture and the United Nations Industrial Development Organization (UNIDO), prepared by Chaoyang Heavy Machinery Co. Ltd., (hereinafter referred to as "the contractor") related to the project of "Energy Conservation and GHG Emissions Reduction in Chinese TVEs-Phase II".

This document is to report in the categories of 6 tasks of contract No. 05/036, which is entitled "Technical Renovation on Shaft Kiln Production Line for Energy Efficiency at Huangshi Lufeng Cement Co. Ltd." and is intended to improve energy efficiency of this pilot plant by upgrading its production technology and product quality.

These 6 tasks are:

1) Devise a preliminary design for the proposed renovation
2) Propose a list of equipment required
3) Review and evaluate the design and drawings
4) Retrofit the shaft kiln
5) Provide training
6) Provide on-site technical support

Based on the project progress Chaoyang Heavy Machinery Group Import and Export Ltd. Co accomplished in the first two quarters, the draft final report will make a conclusion of the project progress, as well as a summary of the technical renovation.

2. Summary of progress

Task 1. Devise a preliminary design for the proposed renovation

According to the contract, the contractor organized a kick-off meeting and devised a preliminary design for the proposed renovation, including selection of the technical route, production process, equipment and materials, budget and timing, and the projected energy saving.

Activity 1.1 Briefing and kick-off meeting

During 10th July to 14th July, the project manager Mr. Xu Xiangming, together with the technical chiefs Mr. Zhao Weici and Mr. Liu Wenming went to Huangshi Lufeng Cement Co. Ltd. to discuss and identify the guidelines for the preliminary general design and reached agreements. Mr. Zou Xinlong and Mr. Zou Runchi from Lufeng Cement Co., Gu Huiyuan, Gu Huiyuan (Vice-director of Productivity Center of Building Materials Industry, China Building Materials Academy), and Mr. Chen Zongwu from Shaft kiln study society of Chinese Cement Association attended the discussion and negotiation.

On July 15, a briefing and kick-off meeting was held in Beijing between the contractor, PMO and Hongyuan company. In the meeting, a brief introduction on the following issues finalized: 1) contractor reaffirmed their acceptation of contract price; 2) contractor committed to accomplish the contract task; 3) contractor reaffirmed team members available in the project duration 4) contractor confirmed project timing and workplan.

Team members in this activity include: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun

Activity 1.2 Preliminary general design

During July 16-25, a general design for Lufeng Cement Co. was conducted in

accordance of the company's real situation and the 8 standards /requirements for modern shaft kiln and its energy conservation.

In this period of time, a brief report for the preliminary general design, and selection of insulation materials are generated.

In September, after the review and modification (planned as the task 3), a finalized primary general was completed and submitted with the second quarterly progress report.

Team members in this activity: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun.

Task 2. Propose a list of equipment required

Activity 2.1 Provision of a draft list of equipment required

During the process of devising the general design for the proposed technical renovation, we draft a list of equipment required and attached it as Annex 3 of this report.

Participating team members: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun.

Activity 2.2 A list of equipment

After the review and evaluation of the primary design, the proposed draft list of equipment is finalized. In addition, the project team provided support for the cement company's purchasing.

Task 3. Review and evaluate the design and drawings

Date: 1st -10th September, 2005

Participating team members: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun

Outcome: finalized project design (Annex 2) and list of equipment (Annex 4) and materials (Annex 5).

The review and evaluation on the preliminary general design was started in August and finished in mid-September. The invited participants were coming from the relative project parties, including Lufeng Cement Co. Ltd., the PMO of MOA, Hongyuan Company and the designated expert team by Lufeng Company (Members of the expert team: Gu Huiyuan, Zhao Jieshan, Chen Zhaolong, Jiao Yongdao, Chen Zongwu, Zou Xinlong, and Liao Naicheng).

Activity 3.1 Review of the primary general design

Date: 1st -6th September, 2005

Participating team members: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun

According to the contract and project requirements, a review on the primary general design finished in the first quarter was conducted during September 1-6 in Huangshi, Hubei. The project manager, Mr. Xu Xiangming, and the technical chiefs Mr. Zhao Weici and Mr. Liu Wenming went to the company and held the technical discussion and review with the review and evaluation committee.

Name list of the review and evaluation committee:

Name	organization	profession	Speciality
Zou Xinlong (Director of the committee)	Lufeng Cement Co.	Professor	Cement
Zou Runchi (Deputy director of the committee)	Lufeng Cement Co.	Senior engineer	Automatics/ management
Gu Huiyuan	National Productivity Center of Building Materials	Senior engineer	Cement
Song Junhua	National Productivity Center of Building Materials	Senior engineer	Cement
Li Helin	China Building Materials News	Senior engineer	Law/ technical management

Liu Zuoyi	Information center of China cement association	Senior engineer	Automatics/ information management
Li Xianzhang	China building material economics study-cement committee	Senior engineer	Mechanics
Zhang Chaofa	National Productivity Center of Building Materials	Professor senior engineer	Cement
Zhan Hongwen	Ankang cement association	Senior engineer	Physics/ cement

This review covered the following issues:

a. Selection and identification of technical renovation route

b. Identification of the production process

c. Identification and confirmation of equipment, materials, and man-hour

d. Potential of energy saving and GHG emissions reduction, and its feasibility

A survey on the 20 new technologies of modern Vertical Shaft Kiln are conducted. The 20 new technologies of modern vertical shaft kiln are:

(1) Pre-homogenisation of raw material and fuel;

(2) Homogenisation of raw mix and cement;

(3) The improvement and selection of mix design of raw meal;

(4) Mixing according to rate value and heat compounding with dark meal;

(5) Pre-grinding;

(6) Application of grinding aid;

(7) Energy saving in drying process;

(8) Application of new type of grinding mills;

(9) Application of efficient powder separator;

(10) Pellet forming with pre addition of water and fast firing of the pellets;

(11) Energy saving type of liner for the shaft kilns;

(12) The selection and application of discharge screen;

(13) Operation with inner fire and closed door;

(14) The dust control concerning shaft kilns;
(15) Quality control and management in the production process;
(16) Automation of the production process concerning shaft kilns;
(17) Chemical analysis with instruments and physical testing;
(18) Comprehensive utilization of resources;
(19) Speed adjustment through frequency variation;
(20) Large mills for group of kilns.

16 technologies are adopted in this technical renovation, except (7), (12), (13), and (16).

Comments of the review and evaluation of the primary general design:

(1) The materials of the technical renovation of Lufeng Cement Co. Ltd. are complete, reliable and qualified for the review and evaluation.

(2) The technical renovation includes the processes of raw material pre-homogenizing, raw mix preparation and conditioning, clinker burning, cement finishing process and etc. it is a comprehensive design for the technical renovation to improve product quality, tackle dust pollution, and decrease energy consumption. It adopts most of the 20 new technologies of modern vertical shaft kiln, and can meet the 8 standards /requirements for modern shaft kiln by using the mature and practical process, techniques and equipment.

(3) The high silica acid dosing system can be used for high quality clinker production (stable production for 42.5 level cement with ISO standards), and can decrease the heat consumption of clinker. It is a significant innovation to cement companies with kilns.

(4) An adopted new type deduster is good at air-proof, insulation, anticorrosion, and avoiding moisture condensation.

(5) According to the data for production process and financial analysis, the decrease of energy consumption, management cost, recycle of semi-products and products can make excellent results up to 4 million RMB.

Based on the results of the review conducted by a group of representatives from Lufeng Company, the review and evaluation committee, the PMO and Hongyuan company, the project team gave out responses and adjustments.

Activity 3.2 Modification and adjustment of the primary general design

Date: 10th -15th September, 2005

Participating team members: Xu Xiangming, Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin, Sun Yaohong, Yu Chun

Outcome: A modified general design (Annex 2)

Foundation for the general design:

1) Contract (No. 05/036) of the project entitled Energy Conservation and GHG Emissions Reduction in Chinese TVEs
2) Proposal for Technical Renovation of Shaft Kiln Production Line for Energy Efficiency at Huangshi Lufeng Cement Co., Ltd.
3) Bidding document for Technical Renovation of Shaft Kiln Production Line for Energy Efficiency at Huangshi Lufeng Cement Co., Ltd.
4) Guidelines for application of 20 technologies in modern vertical shaft kiln
5) Standards for Air Pollutants Emissions in Cement Industry (GB4915-2004)
6) Clean Production Law, China

Objectives of the Design:

1) Output per hour of the clinker machine: ≥14t/h
2) Intensity of clinker: ≥53MPa
3) Clinker F-CaO: ≤2.5%
4) Standard coal consumption of clinker firing: ≤ 130Kg/t clinker
5) Total electricity consumption: ≤67kWh/t cement
6) Dust concentration in emission: ≤50mg/m^3
7) CO_2 emissions: ≥30,000ton/year

Contents of the technical renovation in the design

1) Improve pre-homogenizing facilities of raw materials and solid fuel: build a pre-homogenizing stockpile (3000m2) and a shed for limestone (5000 M2) and coal (2000m2);
2) Renovate limestone grinding process, change the old 2 sets of hammer crushers (Φ150 x170) toΦ250 x 1000 to make the size of grinder-feed becomes ≤3 M thereby improving the grinding efficiency; and introduce a

secondary hammer crusher

3) Renew the mix design of raw meal by replacing the old low-silicon high-iron design with one of high-silicon low-iron; and introduce lab equipment and retrofit the dosing system of raw meal thereby setting up a controlling system of feed proportioning based on its rate value.

4) Retrofitting the separator of the grinding mill to increase the separating rate from 50% to about 80%: replace the 4 sets old Φ4.0 separators toΦ700 separators for raw material separating, and replace the 4 sets of old cyclone separators of Φ2000 toΦ700 high-efficient rotor separators.

5) Introduce energy efficient motors onto raw material grinders to reduce power consumption.

The shaft kiln

1) The shaft kiln is considered as the core equipment of the Company's production line and the key sector for energy efficiency of the whole production process. Professor Jiang Zhigan finished the thermal performance design of the kiln in September 2005, and the project undertook the engineering construction to improve the thermal distribution on the kiln internal section thereby reducing the heating difference between the core and the peripheries of the kiln.

Task 4. Retrofitting the shaft kiln

Date: 10st September to 30th December, 2005

Participating team members: Liu Wenming, Zhao Weici, Jiang Zhigan, Chen Wenxin

Venue: Lufeng Company, Hubei province

Outcome: Energy-efficiency technical renovation of the shaft kiln system

Activity 4.1 Design of the shaft kiln lining for energy-efficiency

Date: 10th-20th September, 2005

Participating team members: Jiang Zhigan, Zhao Weici

Venue: Lufeng Company, Hubei province

Outcome: lining materials (Annex 3)

Activity 4.2 Construction

Date: 20th September-30th December, 2005

Participating team members: Jiang Zhigan, Zhao Weici, Liu Wenming, Chen Wenxin

Venue: Lufeng Company, Hubei province

Outcome: construction design (Annex 5)

completion of the lining construction (by 30th October, 2005).

Task 5. Training

Activity 5.1 Technical training on high-silicon-low-iron dosing system of raw meal

Date: 30th September -30th December 2005

Participating team members: Liu Wenming, Zhao Weici, Chen Wenxin

Outcome: Training materials

Key points:

- New dosing system is to meet the characters of raw meal in Huangshi, Hubei, to improve its old high-silicon-low-iron one (KH：0.94±0.02；N：2.3±0.1；P：1.4±0.1;)
- Qsh≤880kcal/Kgcl; improve pre-harmonizing and harmonizing to increase qualified rate of raw meal ≥80%
- Chemical composition for raw materials

	Loss	SiO_2	CaO	MgO	Al_2O_3	Fe_2O_3	Σ
Limestone	41.71	2.75	49.61	1.75	1.50	1.00	98.32
Clay	7.13	67.35	0.53	0.40	16.16	7.02	98.59

Steel slag	-3.15	14.12	34.17	8.55	2.17	41.37	97.23
Coal ash		42.88	7.97	1.25	24.45	15.05	91.60

- Analysis of coal

Wf: 0.85%	V: 6.35%	A: 34.60%	Q: 4981 kcal/kg

- New dosing system

KH:0.94±0.02	N:2.0±0.1	P:1.6±0.1

- Clinker -125kg/ton

Activity 5.2 Technical training on calcinations operation of the VSK with EE lining

Date: 8th Octorber-30th December , 2005

Participating team members: Zhao Weici, Jiang Zhigan, Liu Wenming, Chen Wenxin

Venue: Huangshi, Hubei

Outcome: Training materials

Key points: upon the requirements of calcinations of the new dosing system, provide training to strengthen 3-balance-control by improving ventilating and quality of nodulizing in order to improve VSK's performance in terms of product output, quality, and energy consumption.

Activity 5.3 Technical training on relevant EE technology

Date: 8th Octorber-30th December, 2005

Participating team members: Zhao Weici, Liu Wenming, Chen Wenxin

Venue: Huangshi, Hubei

Outcome: Training materials

Key points: According to the EE design for the technical renovation, provide

training for operators on EE equipment application and operation so as to have better EE effects in the renovated system.

Task 6. On-site technical support

Activity 6.1 Engineering construction of the VSK system

Date: 1st September -30th October, 2005

Participating team members: Jiang Zhigan, Zhao Weici, Liu Wenming, Chen Wenxin

Venue: Huangshi, Hubei

Contents:

- Installation and construction of the kiln
- Technical training
- On-site assistance and control of project process and quality
- Guarantee the carry-out of project design and realization of objectives

Activity 6.2 On-Site Technical Service of Project

Date: 1st September -30th October, 2005

Participating team members: Jiang Zhigan, Zhao Weici, Liu Wenming, and Chen Wenxin

Venue: Huangshi. Hubei

Achievements:

- Technical guidance
- Technical training
- Assistance for Lufeng Cement Co. Ltd. to realize the aim of energy saving and GHG reduction.

Outcome:

- Energy saving system report (Annex 2)
- Training report on energy saving technology (Annex 5)

- The first draft of final report (Has been submitted)

Task 7. Summury of Project

Date: 1st November –15th November, 2005

Participating team members: All participants

Venue: Biejing

Outcome: Final report on technological improvement of energy saving

Contents:

- Summary of project
- Compilation of final report

After completion of the above 7 tasks, Lufeng Cement Co. Ltd. , GEF Project Office of MOA and Hongyuan Energy and Environmental Protection Technology Co. Ltd. should be invited to have a symposium of project summary, to discuss experiences and lessons of the technological improvement project on energy saving carried out by Lufeng Cement Co. Ltd. and the popularization value to TVEs in China in the future as well as to compile the final project report according to the summarized contents and suggestions coming from concerning parties.

Completion of the activity and submission of the report:

- The schemes and construction drawings of kiln liner for energy saving after adjustment and revision (submission to UNIDO, Project Office of MOA, and Lufeng Co. Ltd.) (Annex 4)
- Final report of the project (submission to UNIDO and Project Office of MOA)

3. Summary of the technical renovation

3.1 Before renovation

3.1.1. Main equipment before renovation

No	Equipment	Type	Num	Workshop	Producer	Produ. Date	Purch. Date
1	Ball miller	φ2.2×7.0M	2	Raw material 1#	Chaoyang Heavy Machinery Co.	Apr. 96	96.5
		φ2.2×7.5M	2	Raw material 2#	Chaoyang Heavy Machinery Co.	Apr. 96	96.5
2	Tower shaft kiln	φ3.0×11M	4	Burning Dept	Chaoyang Heavy Machinery Co.	Mar.96	96.5
3	Ball miller	φ2.2×7M	2	Fine grinding 1#	Chaoyang Heavy Machinery Co.	Apr. 96	96.5
		φ2.2×7.5M	2	Fine grinding 2#	Chaoyang Heavy Machinery Co.	Apr. 96	96.5
4	Jaw crusher	400×600mm	2	Quarry Dept.	Shanghai Mine Machinary Co.	Jan.96	96.7
		600×900mm	1	Quarry Dept.	Shenyang Mine Machinary Co.	Jan.99	99.9
5	Hammer crusher	φ800×600mm	2	Quarry Dept.	Songzi Mine Machinary Co.	96.5	96.7
6	Shaft crusher	φ1.5M	1	Quarry Dept.	Xuzhou Shuangma Crusher Machine Factory	99.7	99.9
7	Small jaw crusher	PEX-150×750	4	Burning Dept	Songzi Mine Machinary Co.	96.1	96.6
8	Centrifugal air separator	φ4.0M	4	Raw material Dept	Huangshi Mine Machinary Co.	96.6	96.7
9	Cyclone separator	φ2.0M	4	Fine grinding Dept	Huangshi Mine Machinary Co.	96.6	96.7
10	Frequency variable speed regulation batch scale	M-2000 type	8	raw meal, fine grinding	Shandong Linju Shifan Electronic Equipment Factory	2000.8	2000.12
11	Dryer	φ2.2×14M	4	raw meal, fine grinding	Chaoyang Heavy Machinery Co.	96.3	96.5
12	Balling pan	φ3.5	4	Firing workshop	Chaoyang Heavy Machinery Co.	96.4	96.5
13	Pre-watering granulation controlling	LSK-II	4	Firing workshop	Shandong Jinxing electronic machines factory	97.6	97.10

	system						
14	electromotor	JR158-8	8	raw meal, fine grinding	Shenyang electromotor plant	96.4	96.5
15	Packaging machine		4	Packaging workshop	Tangshan Zhineng Electronic machines factory	96.2	96.7
16	High voltage electrostatic precipitating system	φ2.2-30mA/120KV	15	All factory	Huangshi Nanfang Environmental Protection Institute	97.10	97.10

3.1.2. Production level before renovation

a) Output of clinker per line: 12.0~13.0 t/h

b) Clinker strength: ~50 MPa

c) Free CaO in clinker: ~3.0%

d) Standard coal consumption for clinker firing: ~150 kg/t clinker

e) Comprehensive power consumption from cement production: ~75 kWh/t cement

3.1.3. Main problems before technical renovation

a) The size of the limestone before entering into the mill is coarse as 20 mm resulting in low efficiency in grinding process and increased power consumption.

b) Instable raw mix quality

At present the rate of acceptable quality for the raw mix T_{CaO} is around 80% while the same rate from advanced Chinese enterprises is higher than 95%. It negatively influences the accuracy in the mixing rate of the meal and causes instable firing process.

c) High coal consumption in clinker firing

The Company already adopted the technology of activating agent from Wuhan Polytechnical University for the raw mix but the standard coal consumption in the firing process is still 150 kg/t clinker. Compared to the advanced level of 130 kg/t clinker the coal consumption is still obviously high.

d) Inadequate dust collection from the shaft kiln chimney

At present the dust collection for the shaft kiln chimney is only done with class I sedimentation room resulting in low efficiency in dust collection and heavy pollution to the environment.

e) Coarse cement particle

firing

At present the cement particle after grinding is relatively course, 5~8% remaining from the 4900 hole mesh which is remarkably higher than the controlled value of 3±1% achieved by other shaft kiln producers which probably has something to do with the type of the cement from the Company but obviously it is also a result of the limitation and influence from the process equipment in the grinding system.

3.2 Objectives of the technical renovation

a) Output from unit cross section of shaft kiln≥1800 kg/h.m^2;
b) Free CaO of clinker ≤2.0%;
c) Standard coal consumption of clinker ≤130 kg/tcl;
d) Comparable(Comprehensive) power consumption of cement≤70kWh/t;
e) Clinker strength: 3 d ≥32 MPa; 28 d≥ 54Mpa;
f) Homogenous coefficient of cement: Cv≤2.0;
g) The dust discharge from the Company meets the standard;
h) The overall per capita production≥1000 t/year.

3.3 Contents of technical renovation

3.3.1 Renovation on raw material system

① In cement production, stable chemical composition of raw materials and fuel are important to the stability of raw mix, and to firing in vertical shaft kiln (VSK), and clinker quality, and therefore to the quality of cement. To improve pre-hormonizing and production efficiency, 6 forklifts of XL30、XL40、XL50 are purchased. These are used for loading, conveying, and unloading of materials for pre harmonizing and chemical tests.

A pre-homogenizing stockpile and a shed for limestone and coal are built. With an investment of RMB80,000, pre-homogenizing facilities are renovated. A limestone shed of 3000 m2 is built. 2000 m2 of two storage rooms for coal and clay are built with a storage capacity of 60,000 tons. A bleachery of 30,000 m2 is built for raw material hardening. These now buildings improve storage capacity and reduce risks of supply shortage.

② Two sets of Φ250×1000 hammer crusher are added (investment of RMB500,000) to make the size of grinder-feed 30 ~ 40cm thereby improving the

grinding efficiency. The size of milled raw materials is smaller than 15-20mm, and above 70% of it should be powder. The average diameter of grinder-feeding limestone should be less than 10mm, and the output per unit is 90 tons per hour.

③ Renovation of raw material drying system is conducted. Fluid-solids kiln system and the lifting flight in the dryer are upgraded, and thereby its calorific efficiency is improved.

④ By the above mentioned renovations, the problems of instable chemical components in raw materials, high humidity, and coarse grains of raw materials are mostly solved, which decrease labour intensity and dust, and improve production capacity. The size of grinder-feed of limestone, fluorite, scruff is≤15mm, and 94 % of them are qualified; humidity of clay, coal, and raw mix is < 5 %, and 94 % of them are qualified. Storage of the raw materials can ensure a production of 20 days. Homogenisation factor of limestone improved from 1:59 to 6.20. The qualified rate of milled raw materials change from 65% to 87.5%.

3.3.2 The mix design of raw material and its dosing system

①The mix design of raw meal is renovated and replaced by the high-silicon low-iron one—KH: 0.92-0.96; SM: 2.2-2.4; IM: 1.3-1.5; Q: 800-900kcal/kgcl. This breaks the rule that VSK cannot produce high-silicon clinker.

②Calcinating process is renovated to overcome the shortcomings of VSK.

③High efficient, fire-resistant insulation material is adopted to solve the heat preservation problem in VSK.

Now the cement company are using the renovated raw materials and raw meal with the same additive materials to produce 42.5 cement with ISO certificate. Clinker heat consumption decreased from 1050Kcal/Kg to 850Kcal/Kg, and clinker coal consumption decreased within 130Kgce. These improve working environment of burner men, reduce harmful gases, as well as meet the targets of energy consumption, environmental protection, cost reduction, and better profit.

3.3.3 The mixing system of raw materials

①Cement companies are usually big electricity consumers. There is a big

potential for energy conservation concerning the old motor-controlled system by changing it to be speed-regulated. The technical renovation has increased electricity consumption of the company, therefore RMB 350,000 was invested for electricity saving. A HP – SLC advancer and a JYQ400 liquid electric resisting barring machine, to imcrease power factor and barring safety coefficient.

② Raw material batching controlling is important and decide the production and quality, as well as energy consumption of clinker. Digital weightless weighting and dosing system is adopted and works together with the controlling system of raw meal rating. This co-controlling system has mad automatic controlling of dosing system in good conditions. In the mean time, chemical wastes are well used after the technical renovation. waste residue and fluor-gypsum, vitriol residue, bauxite have been using compound mineralizing for dosing.

By using multi-element X-ray fluorometric analysis machine, raw material rating batching controller, and oxygen-bomb calorimeter, and such like advanced equipment for the testing and controlling, the goals of comprehensive analysis per hour for raw meal after grinding and heat measuring once two hours are reached. Therefore, the rate for mixing and dosing can be automatically calculated with a qualified rate above 80% and heat control about 2090KJ/kg（500±20kcal/kg）. RMB500,000 was invested in raw mix proportioning to purchase speed-regulated-belt-scale and bucket weightless scale and batching machine. These new equipment will reduce failure caused by mechines. The way of charging for grinding changed from belt-conveying to FU conveying, which can decrease dust.

③ A investment of RMB800,000 was put into the up-grading of separator, which has improved the separating rate from 60% to 75%. Using the existing 5 raw meal storage rooms, and trend guiding device in the storage, the homogenisation factor of finished meal has improved from 1.98 to 5.67, and the qualified rate of finished meal is stable and above 90%.

For the renovation of raw material system, which include contents in 3.4.1, 3.4.2, and 3.4.3., the total investment is RMB2,950,000. The renovation emphasized process control of raw meal before grinding, curculating load rate of raw meal, and raw meal level contral. Therefore, production and quality of raw meal after grinding are improved. φ2.2×7raw mill can keep an output per mill at 33～35t/h; retained percentage at ≤11%, qualified rate≥87.5%, electricity consumption for raw meal processes within 18 degree/t.

3.3.4 Burning system in VSKs

Vertical Shaft Kiln is the key part for a cement company. To upgrade VSK is the best way to improve a company's ability and profits.

Aiming at the problems of Φ3×11 VSK, like low production rate, regular failures, and big cost for fixing, RMB 1,350.000 was invested in the pre-applied water auto-control system, feeding system, kiln's insulating system, discharging system, these are to ensure the quality of nodulizing and burning.

① Adopted speed-regulated technology with an investment of RMB 200,000 for high efficiency, safety and convenient operation of VSK. Power saving by this could reach 8-10%.

② Used high silicon dosing and small nodule burning, and solved too much edge wind. In this way, the labour density was reduced, working environment was improved, energy was saved.

③ The insulating system of 4 kilns were upgraded by using energy efficient materials, and better thermo-design. Investment for this part is RMB500,000.

According to the charactors of the materials using, and burning system, the trumpet end of 13° is the best. Besides, some attempts for inverse ones and higher ones have been taken, and obtained good results.

④RMB100,000 was invested for radial distributors, which will solve the problems of blocks in charging, destroyment of nodules in transferring and other mechanical failures. Discharging system adopted a tray-tower combined one, which enlarge the ventilating area from 48% to 54% and improve section ventilating of kilns.

⑤the smaller raw meal nodules the faster for their process of burning. Therefore, small nodules are good for burning speed, quality and production of clinker. The company was promoting the small-nodule-quick-burning technology, and invested RMB250,000 in the renovation of water pre-adding nodulizing system: digital screw agitate scale was adopted to measure raw meal powder, remote flow meter, frequency variable speed regulation pump, and industrial PC controlling (IPC)system were used to measure and track water and raw meal, to make the size of nodules between Φ5-8mm, water content at 11%-12%. It reduced the heat loss in vaporizing during clinker burning, and shortened clinker burning time, therefore improve energy efficiency.

⑥ RMB1,600,000 was invested in the upgrading of dust collecting system. Four concentric water-electric dust collectors were bought to increase the efficiency.

In burning system, there is totally an investment of RMB2,650,000, including dust collectors. After the technical renovation, VSK of φ3.0×11m can maintain an output of 13.5 ~ 14.5t / h, clinker fcao qualified rate above 80%, qualified rate of loss is above 90%, compression strength of 3-day above 32Mpa, 28-day above 54Mpa, clinker heat consumption is around 3590KJ/kg (860kcal/kg) , standard coal consumption is within 126kg, electricity consumption in burning process is within 22kwh / t.

3.3.5 Cement producing system

①Ball crusher is the most electricity consuming equipment in a cement company, and does influence on electric machinery.

In recent years, the company has invested RMB 300,000 for φ2.2×7m ball crushing system, and installed a HP－SLC static advancer and YBI－1 and WPI－07 liquid electrical-resistant barring machines.

②RMB 150,000 was invested to upgrade the old weightless scaling dosing system to ensure the correctness and stable quality of raw meal. RMB 400,000 was used to change the old Φ2.0Mcyclone separator for the φ2.2×7.0 m cement mill toΦ700 split turning separator. This new separator is more efficient, less potential of problems, and higher output. The electricity consumption concerned also reduced from 53kWh to 28 kWh per ton.

③According to cement quality regulations, standard deviation of compression strength of 28 days should be less than 1.65Mpa. The company。The company has invested RMB 150,000 in the dosing system with computer-controlled weightless dosing machine and air proof scraper transporter, and using industrial waste residue, fly ash, fluor-gypsum, furnace bottom drefs, alumium sulphate, and such like wastes as milling materials.

To improve storage capacity, turnover and homogeneity, RMB3,500,000 was gradually put into building of 13 round storerooms ofφ8×20m, and renewed the storeroom for cement products to 3500 m2. Pneumatic pumps were also adopted to improve storage capacity and homogeneity.

④ to improve the quality of bulk cement, an investment of RMB800,000 was used to upgrade the processes of producing bulk cement by adding 4 φ8×18m storerooms, and two sets of bulk cement machines. The capacity has improved from 150t/d to 300t/d.

The technical renovation in cement producing system had an investment of more than RMB 8millon. The company now has a daily production capacity of 1500t as well as more reasonable and stable cement grain grading and actual weight after the

progress of cement production capacity through technical improvement. Specifically, the annual production for eachφ2.2×7m cement miller maintains 18-20t/h; the surface area is more than 360m2/kg; the qualified rate is more than 85%; the compression strength of 3.25 cement of 3-day is 20-23Mpa and of 28-day 38-41Mpa, its qualified rate more than 80%; the primary qualified rate of the soundness for mill or company cement stand over 98%; the consumption of power used for cement grinding will be controlled under 27kwh / t and the combined power consumption will be within 67kWh for each ton of cement production in the plant.

3.3.6 Testing system

① RMB250,000 were used in upgrading of lab. Multi-element X-ray fluorometric analysis machine, oxygen-bomb calorimeter, and pressure machine, and such like advanced equipment for the testing were equipped. These now are in use of raw material control, heat generation of coal and heat test for discharged raw meal, raw meal rate control, clinker strength monitoring , and output testing. The X-ray fluorometric analysis machine and oxygen-bomb calorimeter can help the cement company to realize its quality management from resources, and make possible for detailed control by testing twice for the materials and store level per day.

After renovation, raw meal rating: KH 0.94±0.02, n is around 2.2±0.1, P is abut 1.4±0.1, qualified rate for feeding raw meal above 90 %; heat for raw meal is 2150KJ/kg(510±20kcal / kg), clinker heat consumption reduced from 4390KJ/kg(1050kcal/kg) to 3690KJ/kg(880kcal/kg), clinker silicate around 73 %.

② Cement production can consume quite some industrial wastes. In lufeng cement company, it is also a key rule to make good use of wastes while ensuring high cement quality. For the renovated raw material system, vitriol dregs, waste mullock, and fluor-gypsum are used. In the cement production process, slag, flying ash, alumium sulphate, fluor-gypsum are in use. These utilization of industrial wastes can increase both economic and social benefits. And the company is honoured as advanced enterprise of resources integrated utilization for years.

③ Technical training and quality management courses are enhanced. In these two years, more than 600 technical training and meetings were participated. Taking the advantage of applying to ISO9000 certificate, systematic management training were organized.

3.3.7 Renovation concerning environment

3.3.7.1 Dust treatment in raw material and milling system

① 4 electric dust collecters and one KFD-2.2M concentric dust collectors are using in crushing and drying systems. In the mean time, the falling gap and speed are slowed down with adoption of FU airproof transporter to solve dust problems.

② Dust problems in milling system was also solved by: adopting FU and lifting air-proofed transporting, and adding more efficient separator and dust collector with better ventilating.

③ In dosing system of raw material and clinker, and clinker transporting system, 11 sets of KFD-2.2M concentric dust collector are installed to ensure a clean environment for dosing.

④Reverse jet bag filter and tree tri-separator were adopted in milling system to improve its vatilating and outputs, as well as to increase milling quality and decrease dust. For cement packaging, a JH/1 jet bag filter was installed to improve the working environment of packaging.

3.3.7.2 Treatment in burning system

Vertical Shaft Kilns (VSK) is the most polluted type of kiln in cement industry. Dust and smoke from VSK is the most tough part for treatment. That is because VSK's performance is not stable, its dust and smoke contains humid with causticity, and density of smoke and dust is high and not stable. Aiming at the above characters, we did measures as follows:

① improved process before burning in kiln, good homogeneity for feeding raw meal, for high quality raw meal and it heat needed.

② up-graded equipment and technology in burning system to ensure stable operation and quality.

③ adopted suitable concentric high voltage static de-dusting technology to ensure the density of smoke and dust lower than ≤100mg/m3, and realized the goals of energy saving, heat preservation, anti-dew, erosion resistant, and stable operation with good performance.

④ trainings for operators. It is important for the operators to know the new technologies and process, such like small nodule, way of burning, smoke in kiln should between 65℃-120℃.

3.3.7.3 Better working environment with more greens

RMB700,000 was invested to build a garden factory to change the old image of a VSK cement company in people's mind.

3.3.7.4 Dust emissions and collection in each process

Testing results: Entrance: SO_2 average emission density 1363mg/m 3 ;
NO_x average emission density 142mg/m 3 ;
Exit: SO_2 average emission density 953mg/m 3 ;
NO_x average emission density 84.6mg/m 3

Position of testing	frequency	Ave. density mg/m^3	Range mg/m^3	Tem °C	Flow speed m/s	Ave. flow Amount M^3/h	Emissions Kg/h
Entrance	1	2424	2096-3072	61	12.9	57100	—
	2	2008	1808-2160	61	12.8	56600	—
	3	2427	2080-2736	61	12.2	53900	—
Average		2286	1808-3072	61	12.6	55900	128
Exit	1	927	80.5-100	42	3.83	56000	5.20
	2	111	100-119	42	3.60	52800	5.86
	3	98.4	82.8-114	42	3.65	53600	5.28
Average		101	80.5-119	42	3.69	54200	5.48

De-dusting rate:95.71%, qualified according to the national standards

3.4 Main economic indicators after the technical renovation

3.4.1 Products quality

Clinker output per machine: 14.2t/h; strength of clinker: 3days: above 32.2MPa, 28 days: above 54MPa.

Clinker f-CaOless than 2.5%, qualified rate of 90%;

Loss≤1%, qualified rate 98%;

Qualified rate of first soundness test of discharged cement 99.5%;

3-day strength for the major product 32.5 cement 18-20MPa ;28-day strength 38-41MPa .

3.4.2 Stable quality of cement products

Coefficient of variation of compression strength of 28-day is 1.5%.

3.4.3 Environmental Protection

The concentric high-pressured static dust collector was introduced to VSK, and reduced emissions to 35.5mg/m, the drying emission is less than 100mg/m, and the dust emitted by mills is under 100mg/m. All the above figures met to the national standards according to the check report of municipal environmental bureau. Meanwhile, the company has made investment in environmental building for several times in recent years, the areas covered by green plants has increased by 5000m, valued RMB150000 altogether, and was awarded "garden company" by the authority of Tieshan town and Huangshi City.

3.4.4 Energy Consumption Index

The standard coal consumption for clinker is less than 126kg / tcl, its heat consumption is 3690KJ / kg (880kcal / kg), and the comprehensive power consumption is under 70Kwh per ton cement.

3.4.4.1 Coal Saving: 4×(150-126)×14.2t/h×7000h= 9542.4tscc/y
Conversion to Real Coal: 9542.4×7000/5300= 12603t/y

3.4.4.2 Power Saving: (Annual cement production is supposed to be 500000 tons)

(75-67)×500000= 4000000 kWh/y

The coal saving is 1592 tons, which is 2103 tce. (It is supposed that the coal consumption for power is 398gce/kWh)

3.4.4.3 CO2 Emission Reduction: (12603+2103) ×0.65×44 / 12= 35049t/y

Energy consumption during Jan-Dec, 2005

Worhshop	electricity	outputs	Elec. Consumption/product	Average elec. Consup/prod.
Whole company	2950266.66	43163.20	68.35	68.35
Crushing 1	38669.25	19871.97	1.95	1.805
Crushing 2	32699.16	19723.75	1.66	
Raw meal 1	481112.08	25209.47	19.08	18.54
Raw meal 2	467069.41	25946.53	18.00	
Raw meal 1/ average	519781.33	25209.47	20.61	19.93
Raw meal 2/ average	499768.57	25946.53	19.26	
Burning 1	275487	14914.18	18.47	18.59
Burning 2	290147.5	15498.17	18.72	
Burning/average	795268.33	14914.18	53.32	52.14
Burning/average	789916.07	15498.17	50.96	
Fine Milling 1	627798.41	19219.59	32.66	31.33
Fine Milling 2	642902.5	21421.85	30.01	
Average of all processes	1423066.74	19219.59	74.04	70.46
Average of all processes	1432818.57	21421.85	66.88	

3.5 Benefit Analysis for the Technical Renovation

3.5.1 After the technical renovation, the integrated power consumption for cement production declined from 75KWH to 67KWH / T; the standard coal consumption of clinker decreased from 150kg / t to 126kg / t, and the annual energy saving is about RMB 3 million, 500000 tons of cement production is supposed.

3.5.2 By investing in construction of storerooms for raw materials, clinkers and cement, the capacity of stock is increased and therefore effects of homogeneity are enhanced.

Advanced testing equipment are introduced to improve the quality rate of raw meal and the quality stability of semi-manufactured goods during production. The quality rate of clinker f-CaO、loss increased from 75% and 80% in 2004 to 95% and 98% in 2005. The compression strength of clinkers for 3 days and 28 days has raised

from 28MPa and 49.5Mpa in 2004 to 32.3MPa and 53.5MPa in 2005 respectively. The compression strength of 32.5 grade cement for 3 days and 28 days still maintains about 20MPa and 40MPa.The homogeneity coefficient of variation are controlled within 1.5%, the of admixture increased from the original 10% to over 35% now, therefore , the cement quality level is gradually improved stably.

3.5.3 All the dust emission sites met with the emission standard which was fully praised by local environmental department and improved the conditions of plants and those surroundings effectively by the way of technical renovation. The active greening and planting of company, such as increasing the area of greening to 5000m has made a significant progress in safety production level of company.

3.6.4 In recent years, the company invested more than 8 million RMB in technical upgrading with a principle of "energy consumption being the priority, environment protection being the core issue and recycle economy and benefit enhancement being the target". This result in a fundamentally conformity and improvement in all the productive elements, such as the cement production, quality, energy consumption, dust control and the whole display, technological equipment level of the company as well as the capacity for stock and turning over of various of materials, semi-manufactured goods and manufactured goods. Taking the real effect of energy saving brought about by the technological improvement, such as coal and power, as well as the production and demand from market into account, the investment of 8mRMB can be taken back entirely within 2.2 years.

Annex 1 Expert list for the technical renovation

SN	Position	Name	Office	Current specialist	Professional title
1	Committee director	Gu HuiYuan	National construction material trade productivity promotion center	Silicate project	Deputy director
2	Vice committee director	Zhao JieShan	Professional committee of cement of Chinese building materials industry research association	Cement	Director
3	Committee member	Zou Xinlong	Lufeng Cement Co.	Silicate project	Vice president
4	Committee member	Chen ShaoLong	Architect Dept., Jinan University	Construction material	president
5	Committee member	Jiao Shuidao	Environmental protection institute, Hefei cement design and research academe	Environmental project	Chief of institute
6	Committee member	Liao NaiCheng	Construction Material Association in Shandongprovince	Construction material	chairman
7	Committee member	Chen ZongWu	China Cement VSK Association	Construction material	Deputy chairman

Annex 2: Finalized preliminary general design for the proposed technical renovation

1. Project Background

1.1 Introduction to Lufeng Co.

Founded in October 1995, Huangshi Lufeng Cement Co. Ltd. (hereafter as the Company) is located in Tieshan District, Huangshi, and owns limestone and clay mines and four Ø3× 11M shaft kiln production lines. In addition, the supply of copper slag is available locally. With a brand of "Lufeng", the company registers an output of PO32.5, PO42.5 and PS32.5 of over 500,000 tons annually, which is popular in Wuhan and the nearby regions and awarded as the Top Product ("Hongbang Chanpin") by Wuhan Municipal and the Famous Brand by Hubei provincial government. As one of the top 10 enterprises in cement industry in Hubei, the Company has passed certification of ISO9002, and has been credited as an "AAA- grade" (the highest grade of credit) customer by the Hubei branch of Agricultural Bank of China for years.

Since it has been identified as a pre-selected pilot TVE under the Phase I of the UNIDO project entitled "Energy Conservation and Greenhouse Gas Emissions Reduction in Chinese Township and Village Enterprises" in 1998, the Company has conducted several technical renovations onto their two Ø 3×11M shaft kiln cement production lines, including: 1) limestone crushing system; 2) utilization of mineralization agents; 3) raw mill; 4) pre-watering palletizing process system ; 5) non-circulation static phase advancer; 6) dust control; and 7) clinker fine crushing. As a result, these renovations led to significant energy savings and GHG emissions reductions for the Company including 4700 tce, 2.36 million kWh of electricity, or 18,328 tons of CO_2 emissions reduction annually.

1.2 Equipment and production lines before renovation

i. There are four Ø3×11M shaft kiln production lines, besides the No. 1 production line has installed with a dust extractor, the other three are emitting without any treatment and cause tremendous pollution, low production efficiency, and large heat consumption.
ii. Four pulverizers for raw materials and four ball pulverizers have been installed with concentric dust extractor, but most of them show an unstable effectiveness, low production efficiency and high electricity consumption.
iii. Proportioning system for raw meal and clinker and the limestone crushing system are emitting without any treatment.
iv. Clinker crushing and unloading system have dust problems
v. Drying machines and loess dryers, although with dust extractors, have space for improvement.
vi. Housetop of the packaging workshop has serious dust-problem.

1.3 Current technical indicators

- Output per hour of the clinker machine: 12.0-13.0t/h
- Intensity of clinker: ~54MPa
- Clinker F-CaO: ~3.0%
- Standard coal consumption of clinker firing: ~130Kg/t clinker
- Total electricity consumption: ~75kWh/t cement
- Total labor efficiency: ~1000t/person.year

1.4 Major existing problems

1.4.1. Limestone is about 20mm and too big for grinding. A crusher can grind 20 tons of 2.2 X 7.0M limestone, but 23 tons of 2.2 X 7.5M limestone. To improve the grinding efficiency and reduce energy consumption, measures will be taken to solve this problem.

1.4.2. Qualified rate for raw meal (TCaO) in the cement company is about 80%, (some companies can reach ≥95%).

1.4.3. High coal consumption. The company has adopted the a raw-material activation technology, but the coal consumption is still 150kg/t, much higher than 1300kg/t, the indicator in the advanced cement companies in China.

1.4.4. Low efficiency of dust collection by using the existing chimney and sentimendation room.

1.4.5 fineness of cement is too coarse, which is about 5-8% of residue on sieve, which is higher than a well controlled figure for shaft kiln (i.e. 3±1%).

2. Objectives of the technical renovation

2.1 Technical-economic indicators after renovation

- Output per hour of the clinker machine: ≥14t/h
- Intensity of clinker: 53~60MPa
- Clinker F-CaO: ≤2.5%
- Standard coal consumption of clinker firing: ≤ 130Kg/t clinker
- Total electricity consumption: ≤65kWh/t cement
- Total labor efficiency: ~1000t/person.year
- Satisfying all environmental requirements/standards.

Comparing to the best enterprises in China, Lufeng Company has already some indicators close to the best indicators, however, it has great energy saving potential in standard coal consumption of clinker firing, which can be reduced from 150kg/t to 130kg/t, and electricity consumption.

2.2 A comparation of the before and after renovation

Table 1. Comparation of the before and after renovation

No.	Indicators	Unit	Before	After	Increase
I. Production scale and products					
1	Clinker	ton	350000	392000	42000
2	Cement P.S 32.5	ton	300000	300000	0
3	Cement P.S 42.5	ton	150000	200000	50000
4	Cement P.O 42.5	ton	100000	100000	0
II. Main production equipment					
1	4 shaft kiln production lines Φ 3×11m	t/h	12.5	14.0	6.0

2	4 crushersfor raw meal Φ2.2 ×6.5m	t/h	26.0	29.0	12.0
3	4 cement grinding Φ 2.2 × 6.5m	t/h	15.0	18.0	12.0
III. Total investment for the technical renovation					
1	Investment for technical renovation	10,000RMB		620.00	620.00
2	Newly added circulating fund	10,000RMB		80.00	80.00
IV. Indicators for clinker per unit					
1	Heat consumption in firing	kJ/kg	4391	3952	-439
2	Standard coal consumption in firing	kg/t	150	126	-24
3	Real coal consumption in firing	kg/t	191	166	-25
4	Investment per ton clinker	RMB/t			64.29
V. Indicators for cement per unit					
1	Investment per ton cement	RMB/t			54.0
2	Electricity consumption in production	kWh/t	75	67	-8.0
VI. Economic evaluation indicators					
1	Internal rate of return for total investment	%		63	
2	Return period for total static investment	year		0.9	
3	Terms of payment	year		1.0	
4	Investment profit rate	%		54.4	
6	Investment profit and tax rate	%		62.3	

3. General design of the technical renovation

3.1 Integrated technical renovation on raw meal and raw material system

3.1.1 Use the existing electro-batching-belt-scale dosing system at bottom storeroom, together with the multi-element analysis instruments and caloric measurement apparatus, built the mathematics model for fast adjustment of raw material rate, through quick analysis of Ca , Fe , Si , Al and caloric in raw material, adjust and control all the supplies flow in time, in order to realize the control of three rates and mix of the raw material, to guarantee to stability of rubing the raw material;

3.1.2Presently, qualified rate of raw meal is about 80%,which is at the medium level, while the advanced factories usually reach 90%-100%. Normally the output will raise about 1 ton / hour for one machine when the qualified rate of raw material increase 10%. If the pre-homogenizaing field for the lime stone can't be built because of the shortage of fund, the raw material storehouse will be reconstructed, the homogenization diversion equipment will be added, the raw material homogenization coefficient will be increased, then the multiplication of raw material homogenization will be increased 2 to 4 times, to ensure that the

qualification rate of raw material entering the kiln is ≥90%;

3.1.3Improve and complete the existing lime stone broken system, transform the original vertical scroll type breaker into ultra-fine broken CXLΦ1000×1200; meanwhile make necessary adjustment to the grinding body gradation, loading capacity, the circulation load rate of the powder selection machine, etc., reduce the amount of sieve residue of 0.20mm square hole sieve, to improve the burning capacity of the raw material;

3.1.4Raw material dosing system: change the original low silicon high iron scheme (KH: 0.91, SM: 1.9, P:1.2) to high silicon low iron scheme (KH: 0.94, SM: 2.3, P:1.4) ; increase multi-element X fluorescence analysis instruments and oxygen bomb calorimeter, make technical renovation to the timing belt balance and weightless balance, to form the rate mixing control and improve the raw material quality;

3.1.5Transform the mill and the powder selection machine. The existing Φ4.0M centrifugal powder selection machine is the first generation product, having low efficiency in powder selection and hard controllability. At present the newly built factory or the technical renovation project usually adopts high-efficient rotary powder selection machine. The efficiency of selecting can increase to about 80% from the original 50% after the technical renovation;.
3.1.6Gradation adjustment of inner balls and forging and technical application of activated lining board:

The analysis data of the lime stone ore from this factory reveals that there is a large portion of coarse crystalline marble rock which, although belongs to the carbonic acid rock, affects the calcinations quality of clinker because it is hard to grind and to melt to join the solid state reaction when in the kiln. And there will be more free calcium oxide and silicon dioxide remaining in the clinker which lowers the quality of clinker and stability of the cement. Therefore it is necessary to carry out the technical renovation in the whole system including the powder selection machine to improve the burning capacity of raw material and reduce the burnt heat.

3.1.7Mill energy-conservation: Adopt a pole changing start circling motor to reduce the starting electric current, which will conserve the energy up to 5%.

3.2 Technical renovation on burning system

3.2.1Perfect the prewetting nodulizing system

Fully utilize the overflowing and voltage-stabilizing function of the existing flow-stabilizing storehouse, ensure the stability of raw material level in it; the stabilizing reamer adopts the measures as changing-speed and changing pitch of screws and diameter, to ensure the voltage-stabilizing, the flow-stabilizing and the buffering functions of the discharging system. The raw meal flow measurement equipment adopts the drift scale with 3-piont suspension, the water measurement adopts the frequency control to control the bump; use the computer system to control the whole material and water system, to enable the automatic production. Make proper improvement to double-shaft agitator and nodule maker: adopting the electric combination scraper, clearing the plate bottom, and improve the edge doctor, to realize the whole plate nodulizing and the percent of balls with diameters of 4-7mm above 90%. Adopt he quick calcinations technology and save the coal up to 5%.

3.2.2. , Distributing Device:

Replace the existing worm gear worm moderating machine transmitting distributing device with new-type device; eliminating the inclined fire in SVKs due to the unevenness in the distributed material in the original device; meantime adopt the central-distributing for the new

device. With no encrustation generating and no mechanical breakdown, the normal running rate of the kiln system is raised.

3.2.3Adopt the energy-conserving kiln lining technology, strengthen the heat-keeping capacity of the kiln, decrease the temperature difference between sections, to improve the calcination quality through conserving the energy. The application of this technology can reduce the heat consumption of the clinker to 500—800kj/kgcl, saving the coal up to 10~20%.At the same time, because the distributed coal is reduced, the ventilation is improved, the calcinations is speed up, which all contribute to clinker production improvement and the stability of quality. This technology is one of the "500 energy-saving technologies" recommended by the former State Economic and Trade Commission, planning commission, State Scientific and Technical Commission jointly (Certificate Number: JNCPN941277).

3.2.4Improvement of the unloading system

At present the fine-toothed comb in tower-style unloading system has small ventilating area (only 40%) and has poor capacity in breaking the material and arch, which affects the clinker quality and production in some way. Replace the existing unloading machine with the new equipment with changeable toothed comb. In this way the breaking capacity is improved, the dropping of the material is balanced in the vertical kiln section, the unloading is smoothened, and consequently there will be less kiln blocking, etc. Meanwhile since the ventilating area is increased to 56%, there is less obstruction in ventilation and the section temperature field in the kiln becomes more even, more steady, which helps a lot in improving the clinker quality and realizing the good-quality-and-high-output.

3.2.5Use the frequency converter related energy-conservation scheme. Adopt the AC frequency controlling fan energy-saving technology to save the electricity up to 5- 10%.

3.3 Technical Renovation of cement grinding system

The cement milling system lacks the effective measuring control of the fly ash, the granules in the cement product being too large, the milling efficiency being too low, and only the low grade cement can be produced. So to adopt an inner screener technology and use the new-type high-efficient rotor powder selection machine to improve the milling efficiency and to meet the requirement for the cement product quality in the new standard.

3.3.1Technical renovation of the clinker breaker

Currently the PC800×400 high thin breaker is used, with passable granules (the size of granule in breaking ≤8mm). But it costs high (one new pair of hammer heads per month on average) and the broken grain becomes larger gradually with the wearing of the hammer head, which influences the control of the grain of milling material and the milling output. The PSL type spraying breaker uses no hammer head and the grain size will be consistent (≤3mm，particle size distribution≥90%). What's more the maintenance is simple and cost is low (only 1/3 of the traditional breaker.)

3.3.2 Technical renovation of the powder selection machine

The existing centrifugal powder selection machine has low efficiency (only about 40%), which has already restricted the full play of system capacity. Especially with the implementation of the new standard for cement, the cement product is required to have fineness and specific surface area. Currently the output is only about 12t/h, which affects the continuous and normal calcinations of clinkers. The high-efficient rotor type powder selection

machine can greatly improve the efficiency of the powder selection (usually more than 85%), the fineness easy to control and the cement intensity being improved with the distribution of cement grain gradation adjustable. Using this selection machine will increase the output up to 16t/h from the existing 12t/h and reduce the power consumption to about 28kWh/t cement from the existing 35kwh/t. Meantime the match with the calcination capacity of the vertical kiln is guaranteed.

3.3.3 Cement homogenization

Make homogenization renovation to the 4 cement storehouse using the homogenization diversion equipment to improve the cement homogeneity and reduce the deviation .

3.3.4 Use the grinding aid technology to reduce the amount of clinker 10- 20%;

3.3.5 Use fly ash , slag , copper slay, reduce dregs from steel factory extensively to economize mine resources and land resource;

3.3.6 Mill energy-conservation: adopting a pole changing start circling motor to reduce the starting electric current, saving energy up to 5%;

3.4 Other parts

3.4.1Technological transformation of environmental protection:

Take environmental protection transformation to the four vertical kiln in the factory and the other dust generating spots. Adopt the non-motive combination dust collector. The reduced smoke and dust of four vertical kiln will be 120,000 ton and the reclaimed cement 8000- 1000 tons.

3.4.2 Enlarge the loose packed cement storehouse to have the capacity of storing 150,000 ton annually.

3.4.3 Cement physical examination:

According to the new cement standard requirement, there should be pressure resistance test for the pressure testing machine with numerical control device. This time the technological transformation plans to use Model HY-30 mechanical full-automatic cement pressure testing machine.

3.4.4 Promote the clean production technology in a comprehensive way.

Table 2. Measures on the technical renovation for energy efficiency in Lufeng Cement Co.

SN	Contents	Status before renovation	Status after renovation	EE effects	Direct benefits
1	the lime stone ele-circling breaking system	output /machine hour 25 tons per hour	increased output /machine hour 40 tons per hour	Increasing the production while reducing the consumption	Improve the output to 60%
2	Homogeniz ation technology in the storehouse	Entering kiln Tc =70%	Improved raw material quality TC =90%	Energy-conser vation is 5%	consumpti on reduction 3-5%

3	The raw meal mill renovation	Low output /machine hour 26 tons per hour	Improved output /machine hour 29 tons per hour	Electricity conservation 5%	
4	Prewetting nodulizing	Low production of nodule	Improve the output	Energy-conservation is 2-5%	
5	The energy-conserving related kiln lining technology	poor heat keeping capacity	The temperature of kiln wall is lower than 50 degrees	Energy-conservation is 10-15%	
6	Comprehensive renovation of the mechanical shaft kiln	low output, high heat rate	Reduce the heat rate, improve the output	Reduce the clinker 439KJ	Raise the output to 10- 20%
7	Comprehensive treatment technology of smoke and dust	Serious dust pollution	Add the equipments , such as electric dust removal ,etc.	Save electricity and coal; save the raw materials 5- 10%	Improve the environmental condition (not including drying dust removal)
8	The cement making	low output 15 tons per hour	Improve the output 18 tons per hour	Save electric 5%	
9	Technological transformation of the cement loose packing system	transformation of some equipments	Improve the capacity		
10	Add the laboratory equipments	Dated	Relatively advanced	Improve the process efficiency	

4. Environmental protection, safety and sanitation, and human resources

4.1 Environment protection:

4.1.1Huangshi Lufeng Cement Co. Ltd. lies in the iron mountain area of Huangshi, with a sparse population nearby. The main pollutants are the dust from the workshop and the exhaust gas. The dust pollution treatment has been taken into full consideration when setting up the factory, adopting the dust collecting device in the main workshop and taking dust treatment to breaking system, drying system and grinding system using the high voltage electrostatic dust collector. The technological transformation has taken the dust treatment into full consideration; conducting dust treatment to the vertical kiln using the combinatory electric dust collector and the discharge after treatment meets the national second grade standard requirement (<100mg/ m3). At the same time, conduct necessary control and treatment to the other dust generating spots to ensure that the treatment of both workshop dust and discharged dust meets the standard requirements.

4.1.2 Waste water treatment:

Conduct the clean and oil separation treatment to the cooled water, make recycle use of the waste water after treatment instead of draining it outside. Take separation operation to the waste water gathered from the smoke and dust of the vertical kiln, mud of high density entering the pre-wetting machine for nodulizing use and the clean water entering the water tank upon the kiln for recycling use, not being drained outside.

4.1.3 Noise treatment:

The noise mainly comes from the mill and air-blower. The sound insulation design has been adopted to the mill house, load operating and the air-blower chamber in the vertical kiln. The technological transformation also plans to green the factory, planting trees outside of the mill house, forming the sound barrier.

4.2 Security and industrial hygiene

The security and industrial hygiene is ensured through making corresponding measure and detailed rules according to the laws and regulations of the countries and the actual production conditions. This technical transformation pays a lot of attention to the workshop sections where accidents occur most likely in the cement factory, such as calcinations in the vertical kiln, etc and will perfect the pre-warning system based on the existing one.

4.3 Staff:

After the technological transformation the total number of workers in the factory will not vary, neither does the organization. Only part of the posts will be adjusted. Therefore there's no need for re-compiling the staff's form. Considering the increase of the economic benefit after the transformation, there will be proper raise in the salary per capita through the whole factory, referring to the payroll level determined by the higher administrative offices.

5. Budget for the technical renovation

5.1 Investment estimate:

5.1.1 Investment estimate and construction:

Project	Amount (10,000 RMB)	%
Total	230	100
Technological renovation	4.0	1.74
Equipment purchasing	163.6	71.13
Installation	18.4	8.00
Other expenses	44.0	19.13

5.1.2 *Estimation basis*

Technological transformation project:

a) Estimated based upon the materials offered by relevant specialties and price of local material.

b) Equipment purchasing:

Estimate the prices one by one according to the manufacturer's newest quotation and national statistical prices of some equipments.

c)Installing the project: Draw 12% of the equipment cost.

d) Equipment transportation fee and other cost: Draw 6% of the equipment cost.

e) The expenses of other projects: the basic preparative fee is 8% of the sum of the first part and the second part.

Overall budgetary estimation:

SN	The project and expenses name	Budgetary estimate value (*ten thousand yuan*)				
		Technological renovation project	Equipment	Project Installation	Other expenses	Total value
	Gross investment of capital construction	4.0	163.6	18.4	44.0	230.00
	Percentage %	1.74	71.13	8.00	19.13	100.00
1	expenses for the first part	4.00	163.6	18.50		

(1)	The raw material homogeniza tion		10.0	1.20		
(2)	The limestone breaking		7.2	0.40		
(3)	The energy-cons erving kiln lining		34.00	4.12		
(4)	vertical kiln unloading system		7	0.84		
(5)	vertical kiln air blasting system	1.0	40.0	4.7		
(6)	The finished product powder selection machine		11.0	1.30		
(7)	The cement homogeniza tion		10.0	1.2		
(8)	Vertical kiln dust collecting	3.00	44.0	4.2		
2.	Expenses in the second part				27.0	
(1)	Survey and design expense				10.0	
(2)	Compensati on fee for united test running				4.0	

(3)	employee training expense				3.0	
(4)	The factory greening				10.0	
3.	Basic budgetary expense				17	

6. Financing and economics evaluation

6.1 Financing:

6.1.1 Gross investment for renovation: 2.7 million RMB
Among them: Investment for technical renovation: 2.3 million RMB
Newly supplemented circulating fund: 0.4 million RMB
Currently the interest in construction period and the regulatory tax in fixed fund investment are not taken into consideration (which is zero).

6.1.2 Capital source:

Special fund for GEF/UNDP energy-conservation and greenhouse gas emission reduction project: 70, 000USD (600,000 RMB)
Self-raised fund of enterprise's (including the newly supplemented circulating fund): 8,000,000 RMB

6.1.3 Fund application:

All the investment will be put into use in the first year. The technological renovation lasts 4 months and when completed the designed output and the technical standard requirements should be fulfilled in the same year.

6.2 Project economic evaluation

6.2.1 Benefit analysis of energy-conservation:

Through the above technological renovation, together with the effective technical management, there will be the following estimated result:

a) Coal saved: 4 x (150-126) x 14.2t/h x 7000h= 9542.4 tce/y
Converted raw coal: 9542.4 x 7000/5300 =12603 tons/y
b) Electricity saved: (assuming the cement output to be 500,000 tons per year)
(75-67) x 500000 =4000000 kWh per year
Assuming the coal consumption for generating electricity is 398gce/kWh, 1592 tce can be saved, which is 2103 tons of converted raw coal.
c) Assuming the coal costs 300 RMB per ton, the saved coal expenses each year will be 3.78 million RMB.

d) CO_2 emissions reduction: (12603+2103) ×0.65×44/ 12=35049 tons per year

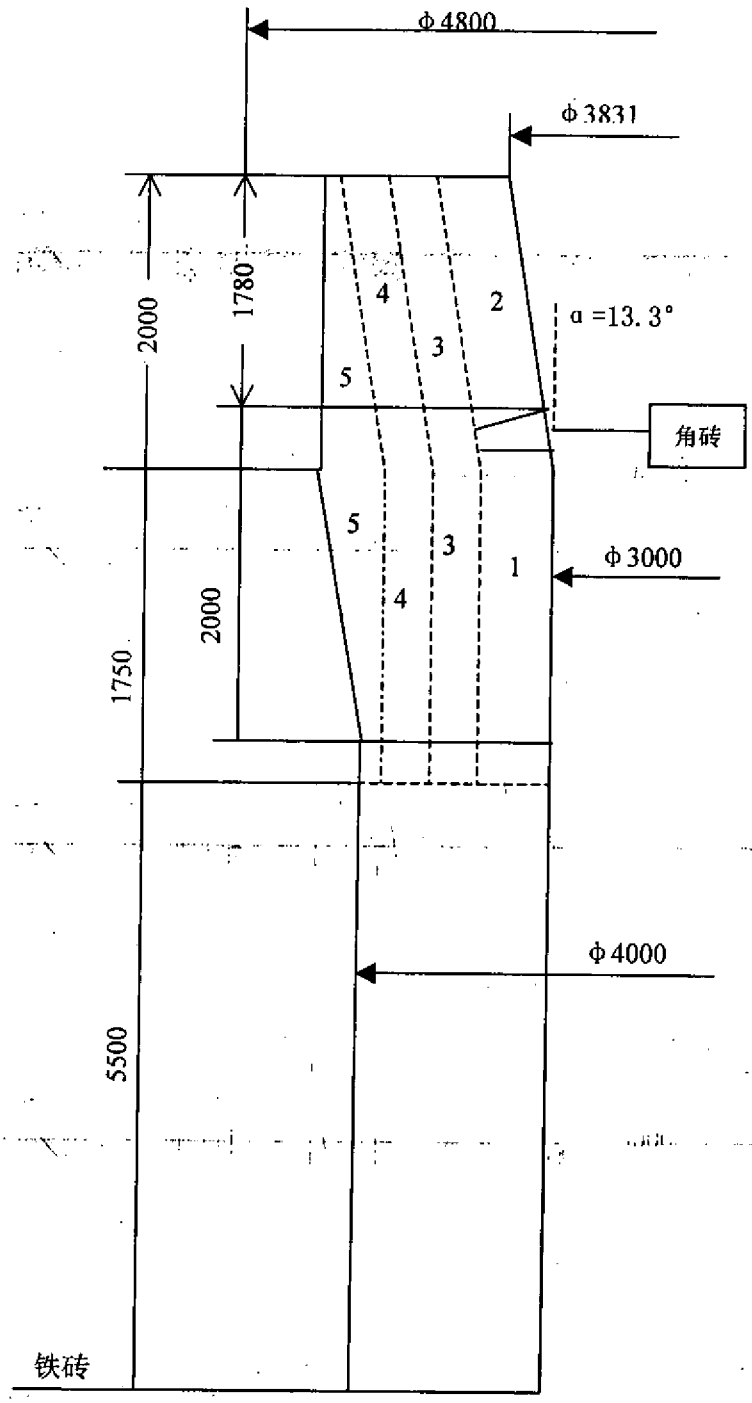
6.2.2 Economic evaluation:

With the total project fund of 2.3 million RMB, an increased annual output of 50000 tons of cement, 12603tce and 4,000,000 KWh of electricity saved annually; there will be obvious energy-conserving benefits. Enterprises will pay off the entire loan within one year; the inside benefit rate of the increment whole investment is 63% and the reclaiming period of static whole investment will be 2.2years.

Annex 3 List of equipment required

No	Project	Equipment / material name	Equipment capacity	Supplier
1	Homogenizing of raw meal	Storeroom spring homogenizing equipment (4 sets)	Coefficient is greater than 3	Wuxi Hushan Energy Conservation Co., Jiangsu
2	Limestone crusher	Φ250*1000 extra-fine (2 sets)	60t/h	Nanjing Xuanli Cement Co.
3	Grinding of raw meal	700 high efficiency rotor type classification machine (4 sets)	40t/h	Wuxi Hushan Energy Conservation Co., Jiangsu
4	Material distributor of SVK	Unbralu-shape distrrbutor (4 sets)	20t/h	Nanjing Xuanli Cement Co.
5	lining	Energy efficient type lining (4 sets)	Silicon-calcium plate's thermal conductivity is less than 0.047W/(M.K)	Henan Mixian Fire-resistent Material Plant
6	Unloading system	Unloading tower comb (4 sets)	Ventilation area more than 55%	Nanjing Xuanli Cement Co.
7	Blasting system	Frequency and Speed Adjustor (2 sets)		Wuhan Industrial University
8	Crushing of clinker	PSLjet-crusher (4 sets)	20t/h	Jiangsu Yancheng Kehang Environment Engineering Co.
9	Classification machine	high efficiency rotor type classification machine (4 sets)	25t/h	Jiangsu Yancheng Kehang Environment Engineering Co.
10	Homogenizing	Storeroom spring homogenizer (4 sets)	Coefficient greater than 3	Wuxi Hushan Energy Conservation Co., Jiangsu
11	Dust collecting	Concentric electronic dust collector (4 sets)	Dust intensity more than 100mg/m3	Hainan Sanya Tianya Cement Co.
12	Lab	300-type automatic compression testing machine, 1 set	Precision level 1	Jiangsu Wuxi Contruction Material Equipment Co.

Annex 4 Construction design of thermal shaft kiln



1——磷砖

90/102×166×200

2——磷砖

90/102×158×200

3——轻质高铝砖

230×65×114

4——硅钙板

300×100×100

300×100×50

径向厚 100+50m/m

5——矿渣浇注料

湖北鹿峰水泥公司 Φ3×11m 机立窑
保温系统砌筑图

Annex 5 Training Report

In line with the plan of energy saving and GHG reduction project of Lufeng Cement Co. Ltd. ,Huangshi, the staff of concerning departments and posts in Lufeng Co. Ltd. received technical trainings.

Activity 1 Technological Training on Batching Scheme with High Si and Low Fe

Date: 8th September- 1st November, 2005

Participating team members: Zhaoweici, Liu wenming and Chen wenxin

Outcome:

- Training Materials of Batching Scheme with High Si and Low Fe (Progress Report of Phase II);
- Calcinations Technology Training Record of Batching Scheme with High Si and Low-Fe (Table 1).

Contents:

- Propose the batching scheme with high Si and low Fe according to the traits of raw fuels of Huangshi Hubei province: KH：0.94±0.02；H：2.3±0.1；P：1.4±0.1
- Propose the essential of implementation of the clinker scheme with pre-condition of heat control ≤910Kcal/kgcl
- Enhance the pre-blending and conditioning of the raw fuels
- Improve the eligible rate of finished meal (≥80%)
- Guarantee the accuracy and stability of that scheme.

Results:

Through the on-site technological training and exchange of views, the concerning participants have already mastered the implementation and control methods for the process such as scheme calculation, meal control, clinker calcinations and cement manufacturing of the batching scheme with high Si and low Fe, and have obtained initial fruits in the practice.

Activity 2 Technology Training on Calcinations Operation of Shaft Kiln with Energy Saving Kiln Liner

Date: 8th October- 1st November, 2005

Participating team members: Zhaoweici, Jiangzhigan, Liuwenming and Chenwenxin

Venue: Huangshi Hubei Province

Outcome:

- Technological Training Materials of Calcinations Operation of Shaft Kiln with Energy Saving Kiln Liner (Progress Report of Phase II);
- Technical training Record on Calcinations Operation of Shaft Kiln with Energy Saving Kiln Liner (Table 2).

Contents:

- Propose a proper calcinations scheme for operation
- Strengthen the control of kiln "three balance" according to the calcinations requirement of the batching scheme with high Si and low Fe and the technical traits of Lufeng Cement Co. Ltd.
- Enhance ventilation and ball-up quality
- Make great improvement in the production and quality of kiln as well as the energy consumption level.

Results:

Trough the on-site technological training and exchange of views, the concerning staff have mastered control method and operation during the clinker calcinations process with batching scheme of high Si and low Fe. In practice, thanks to the use of the fitting refractory kiln liner for energy saving, the section temperature difference between the center and edge inside the kiln is reduced, the calcinations temperature of the edge is raised (1400℃ in real test), the perfect synchronal calcinations of raw meal nodule on the edge is made, these result in the reduction of heat distribution and the free lime of clinker and the improvement of the quality of clinker.

Activity 3 Relevant Training on Energy Saving Technology

Date: 8th October-1st November, 2005

Participating team members: Zhaoweici, Liuwenming and Chen wenxin

Outcome:

- Training Materials of Energy Saving and Clean Production of Cement Technology (Progress Report of Phase II);
- Training Record on Energy Saving and Clean Production of Cement Technology (Table 3).

Contents:

- Train the staff on the application of energy saving equipments in line with traits and requirements of the energy saving equipments chosen in the technical improvement

design for energy saving

- Make the staff master the operation system of energy saving equipments in order to exert the energy saving effect and potential of those equipments.

Results:

Through the training to the technicians and staff of concerning post, with the integration of installation and debugging of the energy saving equipments, the energy saving amounts have come out gradually, and reached the expected results.

Participant List of Technological Training on Batching Scheme with High Si and Low Fe

部门	姓名	性别	进厂时间	现工作工种	培训内容	主讲人	培训考核
生产部门	邹剑峰	男	1995	常务副总	高硅低铁配料方案：KH：0.94±0.02；N：2.3±0.1；P：1.4±0.1，Q：≤910Kcal/kgcl，煅烧技术：压边、盖二肋、提中风，小料球成球技术，变频调速控制技术等	赵慰慈、刘文明、陈文新	合格
	邹志平	男	1996	生产副总			合格
	邹　辉	男	1995	生产副总			合格
	黄少祥	男	1996	总经理助理			合格
	程良旺	男	1997	生产科长			合格
技术部门	柯佑明	男	2003	技术总助			合格
	柯善明	男	2004	技术科长			合格
	卢昌寿	男	2003.10	机电科长			合格
质量部门	胡新铭	男	2005	总工			合格
	邹保卫	男	2003	供应副总			合格
	胡德桥	男	2001	化验室主任			合格
	刘立武	男	1968.8	化验室副主任			合格

Participant List of Technology Training on Calcinations Operation of Shaft Kiln with Energy Saving Kiln Liner

序号	姓名	性别	出生年月	证号	发证时间	持证工种	培训情况	培训结果
1	黄贵清	男	1962.7.28	170310034	2003.3.4	锻烧工安全操作技能证	1.培训人员：赵慰慈、江志淦、刘文明、陈文新 2.培训内容：节能窑衬煅烧操作技术	合格
2	徐　辉	男	1974.2.23	170310031	2003.3.4	锻烧工安全操作技能证		合格
3	李明阳	男	1968.8.29	170310032	2003.3.4	锻烧工安全操作技能证		合格
4	姜健池	男	1965.2.13	170310015	2003.3.4	锻烧工安全操作技能证		合格
5	黄朝正	男	1970.10.8	170310033	2003.3.8	锻烧工安全操作技能证		合格
6	李定红	男	1966.5.29	170310018	2003.3.8	锻烧工安全操作技能证		合格
7	潘泳明	男	1968.7.6	170310013	2003.3.8	锻烧工安全操作技能证		合格
8	黄车胜	男	1973.8.26	170310017	2003.3.8	锻烧工安全操作技能证		合格
9	黄德祥	男	1970.12.19	170310040	2003.3.8	锻烧工安全操作技能证		合格
10	胡水林	男	1964.4.10	170310021	2003.3.8	锻烧工安全操作技能证		合格
11	黄开安	男	1964.9.15	170310022	2003.3.8	锻烧工安全操作技能证		合格

12	刘回香	男	1966.10.20	170310037	2003.3.8	锻烧工安全操作技能证		合格
13	邹世发	男	1964.3.29	170310023	2003.3.8	锻烧工安全操作技能证		合格
14	占国宏	男	1958.1.24	170310028	2003.3.8	锻烧工安全操作技能证		合格
15	熊向忠	男	1976.6.27	170310041	2003.3.8	锻烧工安全操作技能证		合格
16	占发腾	男	1971.2.20	170310019	2003.3.8	锻烧工安全操作技能证		合格
17	黄锐清	男	1966.8.11	170310016	2003.3.8	锻烧工安全操作技能证		合格
18	黄友林	男	1964.8.23	170310024	2003.3.8	锻烧工安全操作技能证		合格
19	胡胜军	男	1972.7.17	170310014	2003.3.8	锻烧工安全操作技能证		合格
20	潘金鹏	男	1970.10.18	170310020	2003.3.8	锻烧工安全操作技能证		合格
21	黄世安	男	1958.1.22	170301126	2003.3.8	锻烧工安全操作技能证		合格
22	柯文甫	男	1968.4.22	170310025	2003.3.8	锻烧工安全操作技能证		合格
23	黄爱国	男	1974.7.5	170310035	2003.3.8	锻烧工安全操作技能证		合格
24	刘荣华	男	1966.4.20	170310029	2003.3.8	锻烧工安全操作技能证		合格

25	郭庆义	男	1977.10.2	170310027	2003.3.8	锻烧工安全操作技能证		合格
26	刘书合	男	1957.4.8	170310038	2003.3.8	锻烧工安全操作技能证		合格
27	姜大林	男	1958.10.6	170310030	2003.3.8	锻烧工安全操作技能证		合格
28	袁文胜	男	1968.7.15	170310039	2003.3.8	锻烧工安全操作技能证		合格
29	朱忠平	男	1969.6.8	170310036	2003.3.8	锻烧工安全操作技能证		合格

Participant List of Relevant Training on Energy Saving Technology

序号	姓名	性别	出生年月	证号	取证时间	职业资格	培训情况	培训效果
1	占发腾	男	1971.2.20	170320019	2003.3.8	安全操作资格证	1．培训人员：赵慰慈、刘文明、陈文新 2．培训内容： 1）清洁生产法； 2）环保法； 3）水泥工业大气污染排放标准； 4）现代立窑 20 项新技术；	合格
2	黄友林	男	1964.8.23	170320024	2003.3.8	安全操作资格证		合格
3	胡胜军	男	1973.7.17	170320014	2003.3.8	安全操作资格证		合格
4	黄世安	男	1958.4.22	170320026	2003.3.8	安全操作资格证		合格
5	熊向忠	男	1976.6.27	170320041	2003.3.8	安全操作资格证		合格
6	黄锐清	男	1966.8.11	170320016	2003.3.8	安全操作资格证		合格
7	潘金鹏	男	1970.10.18	170320020	2003.3.8	安全操作资格证		合格
8	姜健池	男	1956.2.13	170320015	2003.3.8	安全操作资格证		合格
9	胡水林	男	1964.4.10	170320021	2003.3.8	安全操作资格证		合格
10	刘回香	男	1966.10.26	170320037	2003.3.8	安全操作资格证		合格
11	占国宏	男	1958.1.24	170320028	2003.3.8	安全操作资格证		合格

12	邹春发	男	1964.3.29	170320023	2003.3.8	安全操作资格证	5)	合格
13	刘书合	男	1957.4.8	170320038	2003.3.8	安全操作资格证		合格
14	姜大林	男	1958.10.6	170320030	2003.3.8	安全操作资格证		合格
15	袁文胜	男	1968.7.15	170320039	2003.3.8	安全操作资格证		合格
16	朱忠平	男	1969.6.8	170320036	2003.3.8	安全操作资格证		合格
17	黄贵清	男	1962.7.28	170320034	2003.3.8	安全操作资格证		合格
18	刘荣华	男	1966.4.20	170320029	2003.3.8	安全操作资格证		合格
19	郭庆义	男	1977.10.2	170320027	2003.3.8	安全操作资格证		合格
20	黄爱国	男	1974.7.5	170320035	2003.3.8	安全操作资格证		合格
21	黄开安	男	1964.9.15	170320022	2003.3.8	安全操作资格证		合格
22	黄朝正	男	1970.10.8	170320033	2003.3.8	安全操作资格证		合格
23	柯文甫	男	1968.4.22	170320025	2003.3.8	安全操作资格证		合格
24	李明阳	男	1968.8.29	170320032	2003.3.8	安全操作资格证		合格

25	黄德祥	男	1970.12.19	170320017	2003.3.8	安全操作资格证		合格
26	黄东胜	男	1973.8.26	170320017	2003.3.8	安全操作资格证		合格
27	潘泳明	男	1968.7.6	170320013	2003.3.8	安全操作资格证		合格
28	徐　辉	男	1974.2.23	170320031	2003.3.8	安全操作资格证		合格
29	李定红	男	1966.5.29	170320018	2003.3.8	安全操作资格证		合格

Huangshi Lufeng Cement Co. Ltd.

LETTER OF ACCEPTANCE

October 15, 2006

To whom it may concern

This is to confirm, on behalf of the plant, Huangshi Lufeng Cement Co. Ltd., that the technical consulting and engineering services stipulated in the GEF/UNIDO contract (Contract No.) for our technical renovation project for energy efficiency has been fully delivered by the contractor, Chaoyang Heavy Machinery Group Import and Export Ltd. Co. and has been duly accepted by the cement company. The project has been fully completed and operating smoothly thanks to the hardworking of the contractor. Servies delivered including the following:

1. Devise a preliminary design for the proposed renovation
2. Propose a list of equipment required
3. Review and evaluate the design and drawings
4. Retrofit the shaft kiln
5. Provide training
6. Provide on-site technical support

For the cement company: Huangshi Lufeng Cement Co. Ltd

Signature of the legal representatives: _____