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PRODUCTIVITY IMPROVEMENT THROUGH MAINTENANCE OF ADVANCED INSTRUMENTS AND ELECTRONIC CONTROL CIRCUITS

DP/IND/84/020/11-23
INDIA

TECHNICAL REPORT - first mission

Prepared for the Government of India by the United Nations Industrial Development Organisation, acting as executing agency for the United Nations Development Programme.

Based on the work of

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ABSTRACT

The Project: DP/IND/84/020/11-28

PRODUCTIVITY IMPROVEMENT THROUGH MAINTENANCE OF ADVANCED INSTRUMENTATION AND ELECTRONIC CONTROL CIRCUITS IN CEMENT INDUSTRY

The first mission has taken place in the time - 21 October 1986 to 17 December 1986.
It's purpose was to improve the practise mathods of maintenance and trouble shooting of advanced instrumentation and control systems like programmable logic controllers , micro processor based process control systems, quality control system , X-ray fluorescence analyzers and other electronic process control instruments in the Indian Cement Industry and strenghtening the national centre - the NATIONAL COUNSIL FOR CEMENT AND BUILDING MATERIALS /N.C.B.M./ within this area.

The mission has been realized by giving lecture to the technical personnel in the Cement Research Institute of India /C.R.I./ and in the Cement Plants as well as technical discusions about the methods of exploitation , maintenance and trouble shooting by different systems and instruments.
The employees of NCBM have been acquainted with the maintenance end trouble shooting during the visits in three cement plants.

Conclusions and Recommendations.

1. Preventive maintenance of advanced instrumentation and process control systems in visited cement plants is particularly neglected.
2. The major obstacle to efficient maintenance and repairing in many of plants is the lack of adequately trained personnel

3. Poor maintenance and repair of quality control systems leads to poor utilization of this systems , poor quality control and high production costs.

4. Lack of standarization of advanced instrumentation , motor control systems , process control systems etc. in Indian Cement Plants. This courses the training , repairing and inventory of spare parts to be a great problem.

5. Waiting time for imported spare parts is very long , it ranges 3 months to 2 years. This requires good planning for procurement in advance.

6. The manufacturers service is not satisfactory. The waiting time being very long.

7. The Instrumentation staff in the National Council For Cement And Building Materials should be reinforced as soon as possible as well as equiped with additional technical means : measuring instruments , PLC's , process computer system with process symulator and organization suitabl. laboratories.
This is especially valid in the case of specialists in the branche of process computer systems.
They should acquaint updated knowledge in their fields through visits in other modern cement plants in India as well as abroad.

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I. INTRODUCTION

A. Background information.

Today the Cement Industry in India comprises of about 100 cement plants with total annual production over 35 million tonnes. Most of the older plants and mini plants with wet or semidry processes are equipped with only certain level of conventional instrumentation.
Few of the recently build modern plants with preheaters and precalciners use advanced Programmable Logic Controller's Motor Control Systems, Process Computer Systems, Quality Control Systems with X-ray Fluorescence Analyzer etc. Unfortunately many of the control systems like industry TV, X-ray spectrometers etc. do not work properly or are not fully utilized due to lack of maintenance as well as failure of adequately trained personall.

The National Council for Cement and Building Materials /N.C.B.M./ , attached to the Ministry of Industry , Government of India is the national centre engaged in Research Technology Development and Transfer , Education and Industrial Services. The Cement Research Institute has an developed ongoing programme of productivity enhancement and modernization. Many of cement plants have already derived benefits while realizing it.

B. First mission Objectives.

The project Productivity Improvement in the Indian Cement Industry and strengthening the NCBM contains a subproject "Productivity Improvement through Maintenance of advanced instruments and electronic control circuits". The expert's work has covered the entire spectrum of activities relating to maintenance instruments and systems,

The special thrust has been placed on:

1. Maintenance , trouble shooting and repair of:
   a/ programmable logic controllers in motor control systems
   b/ X-ray fluorescence analyzers
   c/ quality control systems
   d/ process supervision and control systems and
   e/ other process instrument

2. Maintenance phylosophy
   a/ maintenance procedure
   b/ tools and test equipment as well as special instruments
   c/ maintenance instruction and manuals
   d/ spare parts
   e/ connection to the peocess documentation
   f/ training
   g/ maintenance documents

In realization of this task separate accent has been given to the following problems:

a/ Analysing the couses of malfunctioning and failures of different instruments and systems.

b/ Present maintenance procedures.

c/ Minimum stock level items as well as critical spares requirement which anable plant to run at rated production capacity and quality.

d/ Prevevtive maintenance procedures.

e/ Strengthening the existing possibilities of the HCBM by technical discusions and trainings the instrumentation specialists with respect of the practise methods of empoitation , trouble shooting , repaire and other maintenance problems.

The improvement of exploitation and maintenance of control systems and automatization devices should enable:

a/ To increase the working time of the devices
b/ To better the time factors of the devices /especially the kiln factor/
c/ To decrease the amount of break downs especially those of the rotary kilns coursed by instrumentation problems.
d/ To better the production quality
e/ To decrease the production costs.
f/ To ensure the safety of personnel.

C. Mission Support.

The first mission has been realized in cooperation with the National Council for Cement and Building Materials, New Delhi - which is managed by Dr H.C. Visvesvaray as well as with the Cement Research Institute of India being managed by Dir. D.B. Irani. I deply appriciate their assistance during the mission.

I would also like to express my thenkfullness to Mr K. Kumar - the Program Leeder as well as to Mr V.K. Arora for organization at the mission in all its asspects. It has been very usefull to realize the mission in cooperation with Mr S. Chatterjee and Mr S. Rajendra, who together with me visited the cement plants and gave me many usefull remarks.

I would like to say the cooperation with the technical personnel of cement plants has been very good in all respects. The wide end deep knowledge of these specialists will surelly contribute to improvment of the work of all control and automatics systems.

II. SUMMARY OF FINDINGS AND RECOMMANDATION

Visits could be arranged to only three plants because of the time lack and communication difficulties. This means that observations , recommandations and conclusions drawn are limited.

A. FINDINGS

1. Lack of standarisation of advanced instrumentation , motor control systems , process control systems , quality control systems in Indian Cement Plants.

   Different types of measuring instruments , transmitters, controllers , programmable logic controlers , X-ray spectrometers , computers etc. are used in plants. For exemple - there is a plant, in wich tree different types of PLC's are used. That's why a lot of problems arise by training , repair and inventory of spare parts.

2. Poor maintenance of complicated instruments and systems like quality control system , leads to poor utilisation of this systems , poor quality control and high production costs.

3. Waiting time for imported spare parts is very long , it ranges from 3 month to 2 years. Good planning for procurement in advance is required.

4. Manufacturers service / domestic and foregin / is not satisfactory and waiting time for this service is long.

5. Prevevtive maintenance of instrumentation and control systems in visited cement plants is particularly neglected.

6. Weight feeders for raw materials , kiln feed , coal feed and cement mill feed are not calibrated in some plants.

7. Nuclear weigh feeders do not work satisfactorly.
8. O_2 gas analyser in the kiln inlet do not work because there are problems with gas sampling probe clogging.
9. Industrial TV cameras observing kiln burning zone do no work.
10. Many modifications of analog control loops , control systems and instrumentation equipments have been carried out. While wiring many loose ends left unconnected.
11. Motor Control Systems using programmable logic controlers are supplied via voltage stabilizers only. Supply voltage drips courses malfunction of PLC's and break down in the plants.
12. Uninterruptible Power Supply for PLC are not used or do not work properly.
13. The stoppages of kilns and other equipments are very frequent and range in average between 20 - 60 stoppages in month.
    The most frequent reasons are:
    - trips of power supply
    - mechanical and electrical problems
14. Kiln stoppages coursed by instrumentation and control systems failures amounts to aproximately 0,6% to 0,9% yearly hours i.m. 2.4% to 2,9% of different types of problems / power supply , mechanical , electrical , lining etc./.
15. All standard technical and maintenance documentation supplied usually by manufacturers of instruments and control systems is available in cement plants. Unfortunately , there are not available special service manuals and technical documentation for repair and adjusting some of the electronic control modules.

16. Instrumentation spare parts store has not all indispensable parts and modules. Actual spare parts list is not available with number of plants.

17. Maintenance documentation is not carried out in some plants.

B. RECOMMANDATION and CONCLUSION.

1. Standarization of advanced instrumentation , motor control systems , process control systems etc. in new or under construction plants anables:
   - to organize party stores of spare parts
   - to organize Central Workshops repairing the demaged modules and instruments
   - to organize central training with respect to maintenance and repairing.

   It is advisable to make proper selection of instruments and systems for standaryzation.

2. Preventive maintenance schedule should be elaborated and implemented in selected cement plants for:
   - basic instrumentation
   - analog control loops
   - weight feeders
   - motor control system
   - computer process control systems with peripherial equipments , X-ray fluorescence analyzer etc.

3. Calibration test of raw materials weight feeders , kiln feed weight feeders, coal flow meters, cement mill weight feeders should be done regularly with material. For calibration test of kiln feed weight feeders and coal flow meters with material special instalations with check-weigh bin are necessary.

4. Calibration tests of gas analyzers / O_2, CO etc./ need special calibration gase mixture. These tests should be done periodically.

5. Demaged analogue instruments / with precision class / should be repaired by manufacture services or legalized central laboratories.
   Other broken instruments and modules can be repaired in the plant instrumentation workshop.

6. Suitable type of O_2 gas analyser probe at kiln inlet side should be installed.

7. A good inventory of spare should be kept in cement plants to overcome the supply delay and long waiting for spare parts specialy for motor control systems /PLC/, variable speed DC motors and process control systems.

8. Stock items should be brought under minimum level maintenance by stores, which should also prepare actual stores manual for such items.
   This would greatly help in inventory control and at the same time make parts available for equipment maintenance.

9. Motor Control Systems based upon PLC's should be supplied by a Uninterruptible Power Supply.

10. For safety reasons, second copies of control programms for computers, PLC's etc. / floppy discs, cassete recorder tapes etc. / should be kept in separate room with appropriate condition i.e. temperature , humidity , electromagnetic fields etc.

11. It is advisible to keep the following registers of works done and documents by Instrumentation Group in Cement Plants.
    a/ Instrumentation and control modification record register.
    b/ By-pass circuits register.
    c/ List of pending Jobs to be attached during stoppage.
    d/ Maintenance books.
    e/ Shift logbook.

12. The set of the most usefull tools and instruments for the Instrumentation Workshop and for maintenance is presented in the Att. No. 1.

13. To strenght the National Council for Cement and Building Materials it is recommanded to:

a/ Considerable reinforce the automatics group as well as instrumentations group . Those to be devided into the following departments:
-Instrumentation and control loops.
- Motor Control Systems based on PLC's.
- Computer Control Systems /process control systems/ i.e. Quality Control Systems with X-ray spectrometer, X-ray difractometer etc.

b/ Organize in the Cement Reaserch Institute the following laboratories:
- Instrumentation and analog control loops.
- Control systems based on Programmable Controlers.
- Computer Process Control Systems with Process Symulator.

c/ Widespread the contacts of the NCBM and CRI specialists with the modern cement plants in India.

d/ To train the NCBM and CRI specialists by:

- Working in the Instrumantation Group in cement plants in India organized in the time the systems are being installed and started as well as in the modern cement plants abroad.

14. The next stape of realization of the project: Productivity Improvement through Maintenance of advanced instruments and electronic control circuits should concentrate onto working out a program for preventive maintenance system and trouble shooting procedures for the chosen cement plants this being devided into following groups:
- clasical instrumentation and control loops
- computer process comtrol systems with X-ray spectrometer
- other advanced equipment and systems / telecommunication etc./

and its implementation in the manual version -
- card index system - including mechanical , electrical etc. maintenance.

It would also be of interest to inspect any of the computer system for preventive maintenance offered by some leading world firms /F.L.Smidth , Polysius / in the circumstances being in India.

III. MAINTENANCE AND TROUBLE SHOOTING

A. Introduction.

Maintenance is necessary for:

- Extend the useful life of equipment
- Anssure the optimum availibility of installed equipment and systems.
- To ensure instant operational readiness of all equipment for emergancy us /stand-by units/.
- To ensure the safety of personnel.

The total maintenance picture since the repair times are usually dependent upon interacting combination of following factors which determine the maintainability of a system:

a/ Design / alarms, sygnalization lamps, test points, access etc./

b/ Human factors /e.g. skills, training etc./

c/ Maintenance environment /e.g. tools, test equipment, maintenance boxes, documentation, service instruction etc./

Maintainability is therefore an attempt to achieve some repair time objectives by specifying a combination of disign and human factors together with the maintenance philosophy.

The time of carrying out a repair or preventive maintenance action at control system and levels is interest to the Cement Plants.

Additionally for Cement Plant the following are of interest:

- Costs of prevrntive maintenance /routine maintenance/
- Costs of repair /corrective maintenance and emergency maintenance/.
- Costs of system outage or degred service /loss of revenue/.

The above factors are determined by:

- The frequence of failure.
- The time of repair
- The cost of manpower and maintenance equipment.
- The diversity quantity and cost of spares carried.
- Transportation of manpower and spare.
- The degree of skill required of the maintenance personel.

The first two of these / frequence of failure and time to repair / are parameters of reliability and maintainability.

Major subdivisions of the varions forms of maintenance shown figure 1.

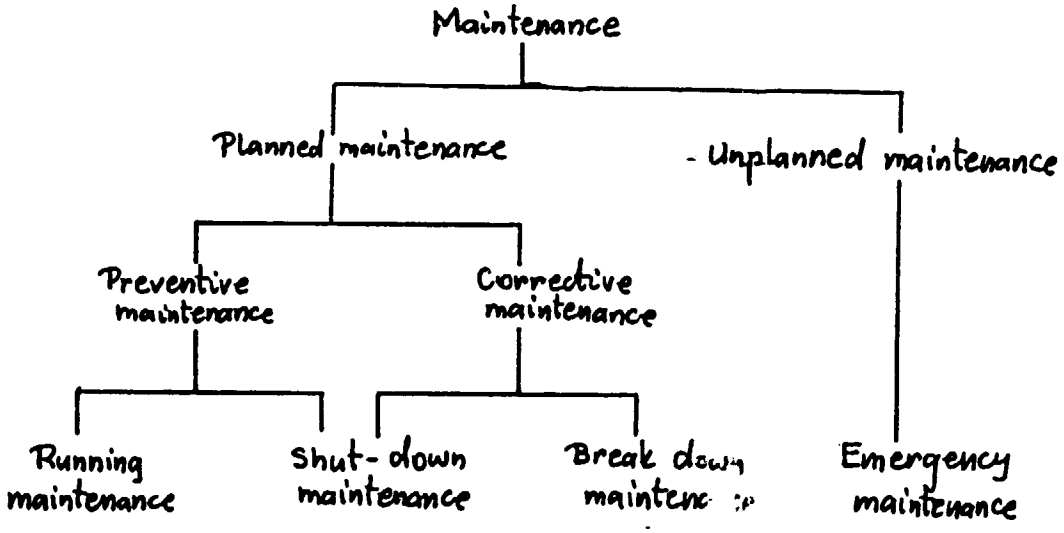

Figure 1: Major subdivisions of maintenance.

Planned and preventive maintenance practiss in Instrumentation Group in Indian Cement Plants are usually neglect. There are only corrective maintenance and emergency maintenance - which mean replacing demaged or bedly working instruments , transmitters etc. The demaged modules are only sometimes repaired in the workshop in cement plant or in the central workshop.

It happens often that those parts are by carying out this repairs completly damaged / kanibalized /.
It is because of lack of service documentations as well as special maintenance equipment which anables searching for damager and repairs the damaged modules.

It is offen the case , when lack of spare parts leads to the modifications into the short circuits in the control systems to be inserted to enable the plant to work.
These " By-passes" may in certain circumstences course damages.

Figure 2 indicate the balance between corrective and preventive maintenance.

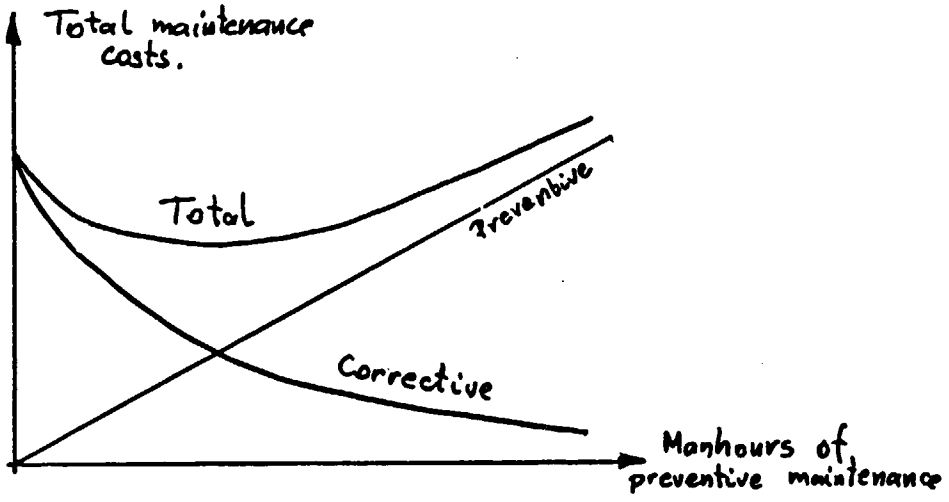

Figure 2 The balance between corrective and preventive maintenance.

The incresement of preventive maintenance costs leads to decreasement of corrective maintenance , olthough the total maintenance costs increase when the preventive maintenance costs are being increased to much.

Preventive maintenance activitie are of four types:

1. The regular care which involves cleaning , checking, oiling, adjusting etc.
2. The preventive replacement and applies to the increasing failure rate situation associated with wear out.
3. Identification of dormant faults.
4. Identification of degradation failures.

Regular measurements , aimed at identifying parameters which are drifting towards the limit of acceptable performance , could result in preventive replacement of the affending component before a failure occurred.

B. The Effect of Maintenance Philosophy on Down Time.

Maintenance philosophy is consideration of the factors:

- Maintenance procedure.
- Tools and test equipment.
- Personnel selection , training and motivation.
- Maintenance instructions , manuals.
- Spare provisioning.
- Logistics.

1. Maintenance procedure.

Effective error-free maintenance carried out in minimum time is best achieved if a logical and formal procedure is followed on each occasion.

This procedure must consist of the following main parts:

- Making and interpreting tests.
- Jsolating the cause of a fault.
- Adjusting to ensure optimum performance.
- Part replacement.

The level of fault identyfication determines the extent of the diagnosis and in electronic instruments and circuits a number of procedures are used:

a/ Stimuli- responce, where the response to changes of one or more parameters is observed.
b/ Parameter checks.
c/ Signal injuction.
d/ Functionell isolation.

Having isolated the fault a number of repair methods present themselves:

- Direct replecement from store.
- Cannibalize from non-essentiel parts.
- Self-repair , i.e. failed unit adapts.

Depending upon the circumstances and location of a unit or a system , a corrective repair may be carried out immediately that a fault is signalled, or, on the other hand repairs may only be carried out at regular intervals / stand-by unit /.

2. Tools and Test Equipment.

The following are a few of the main requirements of test gear:

- Simplicity -easy to use.
- Standarization - the minimum number of types reduce the training.
- Reliability - a test equipment failure can result in a system failure.
- Maintainability - easy to repair.
- Replaceability - easy to change a parts.

3. Personel Consideration.

Four manpower considerations influence the maintainability of equipment:

- Training given.
- Skill level employed.
- Motivation.
- Quantity of personel.

4. Maintenance Instructions.

The most vital repair tool available to the engineers and technicians is the maintenance manual.
It must be accurate and complete for each type of instruments or systems.

The main use of the manual is an aid to diagnostic for which it should out line a logical sequence of tests necessary to identify , by a process of elimination , the causes of a malfunction. Wherever possible . procedures should be self-checking.
This types of service instruction are not available usually in cement plants.
Functional block diagrams assist in the process of fault finding by providing a logical illustration of the checking sequence.
Illustration of booth correct and incorrect conditions speed the process of fault cause recognition.

Other features of the manual should be an out-line of alignment and adjustment procedures.
This types of service instructions are available at manufacturers services but often not supplied with instrumentations and systems to the Cement Plants.

In the case , when it is possible to repair the instrument in the Instrumentation Workshop in Cement Plant the instructions may be delivered by services.

5. Spare Provisioning.

The amount of spares to be provided , which is related to the risk of a stock out , requires the statistical distributio of the failures to be known.

The following main considerations applying to spare provisioning.

- Failure rate - determine quantity required.

- Probability of stock out - fixes level of spares in instrumentation store.
- Cost of spares.
- Repairing spares.
- Standarization.
- Availability.
- Localization of spares:
  - central depot
  - small local /instrumentation/ depot.

6. Logistics.

Logistics is concerned with the time and affort involved in transporting manpower , equipment and spare to their place of application in order to carry out maintenance actions.

C. VISITS TO CEMENT PLANTS.

1. SHREE CEMENT LIMITED
BANGUR NAGAR - BEAWAR (RAJASTHAN)

Shree Cement Limited located at Bangur Nagar - Beawar, Rajasthan was commissioned in April 1985 and produce clinker by dry process using the precalciner system of F L Smidth Denmark. The plant is single line of one kiln designed to produce 600,000 m tpy. The utilisation factor of plant from January to October 1986 more than 120%. Programmable Controllers, alarm annunciation Systems, weigh feeders, field instruments and monitoring Systems have been supplied by F L Smidth, Larsan & Toubro, ASEA Limited and A B Controls etc. The informations gathered during the visit is attached.

The plant has used appropriate instruments on the basis of actual requirement and not used Complicated System in the plant except few analog control loops in Raw Mill, kiln and Cement Mill Sections. For sequencial control, interlocking and fault monitoring system the plant has installed Programmable Logic Controllers at Stacker, reclaimer, raw mill, kiln and cement mill section for plant equipment. However, the Packing Section has less instrumentation and control equipment. Sequencial Control of drives is done by relay logic system.

All D C drives and weigh feeder panels of the plant have been grouped up and kept in completely air conditioned rooms along with Programmable Controllers, since they found it convenient to analyse any faults whenever the panels behave erratically.

OBSERVATIONS AND PROBLEMS:

1. Reclaimer and stacker Programmable Controller's Rooms are not air conditioned. Increase in temperature and dust concentration inside the Panel can cause malfunctions or internal failures of PC Components.

2. Level measurement system at raw materials Hoppers are not installed.

3. Mechanical vibrations in Raw Mill and Cement Mill Local Control Room and Motor Control Centres are too high, which may cause malfunctioning in future.

4. O_2 gas analyzer in the Kiln inlet is not working properly because of problem with gas sampling device.

5. Lack of standarization of the Control philosophy differences, three types of PLC's & weigh feeders are used in plant. These poses a big problem of inventory of spare parts.

6. Analog Control loop for differencial pressure of the Roller Mill controlled by total Raw Mill feed is not working satisfactorily because of the transportation delay.

7. Lack of coal solid flow meter or equivalent equipment for measuring coal feeding to the kiln.

8. Lack of important spare modules for Programmable Controlers i.e. Central Processor and Memory etc.

9. Lack of continous sampling devices in following Sections :

   - raw materials before prehomeogenisation piles.
   - raw meal after roller mill.
   - Cement from the Mill.

10. Lack of Laboratory Automation System with X-Ray Spectrometer for quality control.

11. The plant has well equipped Instrumentation Workshop with tools and maintenance equipment.

12. Good maintenance of instrumentation and controling devices are being carried out.

13. Kiln down-time by reason of instrumentation and control equipment failures amounts to approximately 0.6% yearly hours for 10 months from Jan to Oct 1986.

14. Packing Plant has less instrumentation and control equipment than normally provided.

15. Electrical power supply is not continuous; 80% power cut from Rajasthan State Electricity Board.

16. Scarcity and unavailability of water.

17. About 80% analog control loops are usually working in Automode position.

18. Common grounding is used for PLC & Electrical Equipment.

RECOMMENDATIONS :

1. Air Conditioners should be installed in Stacker and Reclaimer PLC Central rooms.

2. Continuous Sampling devices should be installed for extracting and preparing representative samples from the raw materials.

3. Automation Laboratory System should comprise of sample preparation equipment and on-line X-Ray Analyser for controlling the raw meal and Kiln feed and also quality improvement. Q C X System or equivalent is recommended.

4. A good inventory of spares should be kept to overcome the supply delay and long waiting for spare parts and modules of PLCs, Variable speed D C drives and other equipment.

5. For safety reason, second copies of control program of Programmable Logic Controllers should be kept in separate room with appropriate service condition i.e. temperature, humidity and electromagnetic fields etc.

6. Coal feed weighing or equivalent system (preferably loss-in-weight type) for measuring coal feed to precalciner and kiln should be installed subject to availability of space.

7. Analog Control loops for differential pressure of the roller mill is controlled by total raw materials feed and cement mill filling is controlled by total cement mill feed. These two analog loops should be modified to overcome

transportation lag and the experience from other plants shows that the folaphone signal can be better utilised only as on over riding control or in adaptive control mode.

8. P I D Controlled parameters should be adjusted and checked within normal working condition.

9. Suitable type of O_2 gas analyser probe at kiln feed side should be installed.

10. For detection of minimum limestone level in the concrete crusher hopper. They can instal E C I L Hyderabad Make Gama-ray type level measurement system with electronic relay & interlocking system.

11. Programmable Controllers grounding and Electrical power grounding should be separate otherwise the P C would be exposed electrical noises and leakage currents that may be present in building structure and even electrical conduits.

TECHNICAL DETAILS :

1. Instrumentation and Control Circuits :

a/ Instrumentation

All standard measuring points and instrumentation recommended by F L Smidth are working properly. Some of them were supplied by F L Smidth & Indian parties which are working properly except one or two.

b/ Analog Control Loops

In Shree Cement Plant used relatively low number of analog control loops with PID conventional controllers.

- Raw Mill contains - three analog control loops,
- Kiln and Grate Clinker Cooler - twelve control loops,
- Cement Mill - three control loops,
- Coal Mill - four control loops,

List of analog control loops is given in Annexure I.

c/ Drives Control System

For the sequence of starting, stopping, interlocking, time delay etc in the Shree Cement Plant have used Programmable Logic Controllers (PLC).

Motor Control System is decentralized and divided into the following parts :

PLC 1 - Stacker 80xD/0-24 V DC : 48xD/0-24 V DC

PLC 2 - Reclaimer 72xD/I-24 V DC : 56xD/0-24 V DC

PLC 3 - Raw Mill - 128 I/O

PLC 4 - (C.F. Silo) - Controlled Flow of Silo

PLC 5 - Kiln, E.S.P. and G.C.T. (Kiln, Electrostatic Precipitator and Gas Conditioning Tower).

PLC 6 - Clinker Grate Cooler, Coal Mill and clinker transport

PLC 7 - Cement Mill

There have used 3 types of the PLC's:

- PLC type 2/15 from Allen & Bradley (PLC 1 & PLC 2)
- PLC type MP 160 from ASEA (PLC No. 3, 5, 6, 7
- PLC type 5 T I from Texas Instrument (PLC 4)

These PLC's have different types of the digital inputs and outputs module such as:

- Digital inputs 24 V DC or 48 V DC
- Digital inputs 110 V AC
- Digital outputs 24 V DC
- Digital relay outputs.

Each of these PLC's have different types Programming Devices programming language and hardware structure.

Programming Devices (terminals), which can be used for the introductory programming, documentation to the installing, subsequent updating and trouble shooting are following :

- Intelligent terminal with external cassette tape recorder for the Allen & Bradley PLC 2/15
- Universal Master Aid 214 - intelligent terminal with SCR and 2 Floppy - disc drives 320 k bytes each for ASEA PLC 2/15

- Simple packet terminal without external memory for 5 T I sequence (Texas Instrument)

d/ Power Supply :

Very bad power supply condition in Shree Cement Ltd. Forced application of constant Voltage Stabilizators to correct Voltage Fluctuation and isolating transformers for supply the Motor Control Systems and other equipment Electronic back-up power supply for PLC's and outputs signal (external power supply) is installed there also. Uninterruptible power supply system is not used there.

e/ Grounding :

Grounding system commonnfor all electrical equipment instrumentation and PLC's control system has 1 to 2Ω impedance.

2. Maintenance :

i/ Documentation

a/ Hardware documentation : Instrumentation group has all documentation, supplied usually by manufacturer of instruments and controlling equipment.

Unfortunately, there are not available special service manuals and technical documentation for repair some of the transmitters, electronic control boards and PLC's modules.

b/ Connection to be process documentation : This documentation supplied by designers or manufacturer inplant is complete and good.

c/ Software documentation : Listings of motor control programs with comments to both A & B and ASEA's PLC's are available there in Ladder diagrams or list form representation.

ii/ Tools, maintenance equipment & spare parts

Shree Cement Limited is well equipped with maintenance tools and instruments etc. which are necessary for corrective and preventive maintenance.

Instrumentation storage has many spare instruments, indicators, sensors, modules etc. as well as electronic and electric components which are necessary for repair of damaged instruments and modules.

However, there are not some very important spare module for the PLC's and other complicated control equipment.

iii/ Preventive and corrective maintenance

It was possible to see in the "Preventive maintenance records" and other Instrumentation Group Documents, preventive as well as corrective maintenance have been given in accordance with maintenance philosophy.

List of kiln outage hours due to power supply, mechanical, electrical, instrumentation etc. problems shown in Annexure II.

Table 1 BREAKDOWN DURING JANUARY - OCTOBER 1986
ANALYSIS OF KILN

Month	Power failures (h)	Mechanical Problems (h)	Electrical Problems (h)	Instrument Problems (h)	Other refractory etc (h)	Total stopage (h)	Months hours
1.86	298	13,50	0,66	16,16	50,68	379	744
2.86	24,33	72,42	6,50	3,33	20,08	126,66	672
3.86	0,83	33.0	3.83	5,08	210,18	252,92	744
4.86	11,17	28,08	17,92	5.25	50,88	113,30	720
5.86	6,75	40.50	8,75	10,58	83,75	150,33	744
6.86	8,75	31,92	15,42	1,92	24,82	82,83	720
7,86	4,92	39,42	5,50	0,33	122,83	173,0	744
8.86	11.83	-	9,66	0.50	21,76	43,73	744
9.86	5,42	4.50	8.00	2,08	378,58	398,58	720
10.86	19,48	63,33	10,08	1,42	67,69	162	744
Total	391,48	326,67	86,32	46,65	1031,25	1882,37	7296

Kiln run factor = 74,2%
Power Supply problem - 20,8% total stoppage
Mechanical Problems - 17,4% " "
Electrical " - 4,5% " "
Instrumentation " - 2,5% " "
Other (refractory etc) " - 54,8% " "

2. NARMADA CEMENT CO LTD
JAFRABAD (GUJARAT)

Clinkerisation Unit of Narmada Cement Co Ltd is located at Jafrabad Gujarat, at distance of 160 km from Bhavnagar. The plant is single line dry process kiln with Fuller Flash Calciner designed to produce 3000 TPD Clinker. X-Ray Analysers, weigh Feeders, alarm annunciation systems ha field instruments and monitoring systems have been supplied by Fuller Co USA, Diano Corporation, Merrick, Schenck, Siemens AG, Taylor, Leeds & Northup and Teledyne etc. The informations gathered during the visit is shown in attachment.

The plant has A/c Centralised Control room for Raw Mill, Blending & homogenising, Coal mill and kiln sections. For sequencial control, interlocking and fault monitoring system, the plant has used siemens Control Systems.

The plant has installed on-line and off-line X-Ray Analysers near homogenisation silo and in Chemical Laboratory respectively.

All D C drives control panels and MCC panels (M-Systems Siemens) of plant have been grouped up and kept in one room, since they found it convenient to analyse any faults whenever the panels behave erractically.

Common grounding system is used for X-Ray Computers and other Electrical equipment of plant.

OBSERVATIONS & PROBLEMS :

1. Almost all Level measurement instruments do not work.

2. Though the raw materials weigh feeders (2 x Limestone, 2 x clay and ix corrective material) are not calibrated, performance is stable.

3. Vibration measuring equipments for roller raw mill and coal mill are damaged.

4. Kiln feed solid flow meters are not calibrated.

5. Coal feed solid flow meter to mill and precalciner are also not calibrated

6. O_2 gas analyzer is not calibrated.

7. C C T V does not function properly.

8. Central Control Room and Motor Control Centre is located near production line. Dust can cause malfunction or failure of electro-mechanical instruments like recorders, teletypes , pressive transmitters etc.

9. On-line X-Ray analyzer with computer is located under homogenization silo in a special room. Around this place is a lot of raw meal dust, which can cause malfunction or failure of equipment.

10. On-Line X-Ray analyzer is defective i.e. X-Ray tube is damaged. It was in operation only for 863 working hours.

11. On-Line process computer for raw material proportioning is connected to the process(weigh feeders and set point station) and it has not yet been commissioned.

12. Automatic, continuous sampling device for extracting Sample of raw meal does not work.

13. OFF-Line X-ray analyzer is damaged (floppy-disc controller and safety circuits of X-Ray tube) in February 1986. X-Ray tube was under operation only 1710 hours from 1983.

14. Sample preparation equipment for off-line X-Ray analyser are out of order.

15. Off-Line X-ray analyser is switched-off very often (every day). This can be the cause for the too early damage of X-Ray tube and inaccuracy of results.

16. X-Ray analyses and conducted directly after Switching-on the equipment without waiting for the working parameters to stabilize.

17. Preventive maintenance of instrumentation, automation equipment, computers and X-Ray spectrometers is neglected.

18. Actual Spare parts List of automation equipment is not available in the plant.

19. Waiting time for imported replacement parts is very long, it ranges from 6 months to 2 years. This requires good planing for procurement in advance.

20. Servicing by foreign manufacturers is not satisfactori and also waiting time for this services is long.

21. Lack of many important spare instrumentation equipment and spare modules.

Recommendation and suggestion

1. Level measurement instruments should be repaired or replaced by new. Purchase of new types of these equipment made in India has been recommended and details given to plant authorities.

2. Vibration measuring equipment for roller mills and fans should be installed. This type of equipment from Carl Schenck W. Germany works well in other cement plants.

3. Calibration tests of weigh feeders and solid flow meters with material should be conducted periodically. Recommende material calibration period is 1 to 6 months depending upon the stability of these equipment. For this calibratio test it is necessary to calibrate weigh bridge (raw material) or weigh bin.

4. Purchase of standard calibration gas for calibration of O_2 gas analyzer is recommended. This calibration should be done every few weeks.

5. In central Control Room should be kept pressurised which is done by working ventilation and air conditioner units. Air fillers in these units should be frequently cleaned.

6. On-line Raw Materials proportioning system with on-Line spectrometer for quality improvement and reducing energy costs should be commissioned at the earliest.

Steps to be taken for this are following:

a) On-Line X-Ray analyzer System

- Check earth ground system. (Plant)
- Check power supply system for On-Line X-Ray analyser and PDP8M Computer (Plant)
- Check air conditioners (Plant)

- Check volume system (Plant)
- Maintenance of Water closed circulatory system (Plant) with heat exchanger. 15 litres of distilled water is required.
- Maintenance of Continuous sampling device to and from XEG Sample preparation apparatus (Plant)
- Maintenance of ASR 33 teletype (Plant)
- Maintenance of PDP 8 M Computer & Standard
- Hardware tests of computer and peripherial equipment (Plant or Service).
- Repair of X-ray analyzer (Diano or Fuller)
- Restart of on-Line X-Ray analyzer System (Service)

b) Process Computer PDP 11/34 and RMP System.

- Check grounding (Plant)
- Check power supply (Plant)
- Connection computer process interface to the process
  4 analog inputs - raw mill weigh feeders
  4 analog outputs - set point Stations (Plant)
- Maintenance of PDP 11/34 peripherial equipment
  L A 36 Decwriter
  V T 100 Descope (Plant)
- Maintenance of PDP 11/34 computer
  (Service + Plant)
- Hardware tests of PDP 11/34 configuration
  (Service + Plant)
  CPU, memory, clock, peripherials, disc, input/output system.
- Check teletransmission line between PDP 8 M and PDP 11/34 computers (Plant + service)
- Loading the RMP System programs and starting-up the System. (Service)

Caution: 1. It is necessary to check if RMP system is universal and can be operated only with two components.

2. On-Line X-Ray analyzer should be operated non-stop and the helium atmosphere should be maintained in the head at all times, even during plant shut-down.

7. OFF-line X-Ray Analyzer

For normal operation of Off-line X-ray spectrometer and automation laboratory system following jobs should be done:

- Sample preparation equipment like fine grinding mills and hydraulic press should be repaired or purchase new ones.
- The best are from Herzog Company, W.Germany
  HSM 100-fine grinding mill and
  HTP 40-press
  advise to use one vibration fine grinding mill only for one material.
- New sets of calibration samples for Limestone, Clay, Raw meal and clinker should be done. Chemical composition of these samples should be determinated by two independent chemical laboratories.
- X-ray spectrometer should be repaired by manufacture service
- New calibration of X-ray analyzer should be performed.
- X-ray specialists from Cement Plant should be trained on X-ray spectrometer technique.

Caution:

X-ray spectrometer should be switch-on continuously and operated non-stop by laboratory.

8. For extracting representative sample of raw meal and kiln feed for off-line X-ray analyzer installation of special sampling devices is recommended.

The best point for this is between screw conveyor and air slide in raw meal and kiln feed transportation system. Screw sampler from Polysius Company, West Germany can be installed in this place.

9 Off-line X-ray spectrometer can be connected to process computer via teletransmission line and used like an on-line x-ray analyzer in the raw material proportioning system. For this make necessary small modifications in hardware and software of the off-line X-ray microcomputer and install teletransmission line between off-line microcomputer and PDP 11/34 process computer.

10 Two-colour ratio pyrometer should be installed at kiln hood for measurement of material temperature in burning zone with water and air cooling system. It will help in monitoring and better control of burning zone of kiln. It is recommended to procure Land pyrometer (L&T) or Siemens A G (Siemens India).

11 Inventory of instrumentation and automation spare parts should be done and stock items would be brought under minimum level for maintenance.

12 Preventive maintenance program for instrumentation and computers and X-ray spectrometer should be elaborated.

NARMADA CEMENT CO LTD
JAFRABAD

TECHNICAL DETAILS

A RAW MILL PREPORTIONING SYSTEM WITH X-RAY ANALYZER AND ON-LINE COMPUTER

The system performs continuous automatic control of the proportioning of the 4 raw materials to raw mill.

A continuous sampler equipment extracts raw meal at the entrance to the homogenisation silco. The extracted material is transported by sample transport system to the XE sample presenter apparatous. Sample feed rate is about 130 cm^3/min. in every 15 min. x-ray analyzes the sample and sends to x-ray computer.

The X-ray computer calculated via calibration curve the following oxides :

SiO_2 ; Al_2O_3 ; Fe_2O_3; CaO; SO_3 ; K_2O

This results are transmitted by teletransmission line with 1200b dsspeed to process computer. The computer compares the actual chemical composition of the produced raw meal with wanted chemical composition of the kiln feed defined by possible target values like a;

LSF ; HM ; SM & AM in Kiln Feed

C_3S ; C_2S ; C_3A ; C_4AF ; Fe_2O_3 and MgO in Clinke

In the some time process computer need following input values :

- Bin Oxide composition
- Blender Oxide composition
- Analog value from weigh feeders

These two first composition should be obtained through analyse of bin and blender materials on off-line analyser.

The set-point positioning of the weigh-feeders is made on-line by the computer.

The results from the calculation of raw material proportioning are printed out on a Decwriter.

Figure 1 show general view of RMP system
Figure 2 show on-line x-ray analyser configuration.

Configuration of on-line x-ray analyser is following :

- DTM 1088 X-ray Emission Gauge continuous X-ray analyser from Diano Corp. USA.
- H.T. Generator
- PDP 8M small computer
- ASR 33 Teletype
- Helium system
- Water heat exchanger
- Power supply - NEEL Voltage stabilizer 8 KVA and .E. voltage stabilizer 7,5 KVA.

Configuration of process computer is following :

- PDP 11/34 computer (DEC) with 128 K Byte RAM MOS memory

- Back-up battery for MOS memory
- Two 5.0 MB removable disc (type RLOI)
- Real-time clock
- LA 36 Decwriter
- VT 100 Decscope
- Process interface :
  16 Analog inputs
  4 Analog outputs
- Power supply - NEEL Voltage - stabilizer 8 KVA

B OFF-LINE X-RAY ANALYZER

The X-ray spectrometer determine. the relative amount of 8 elements simultaneously. The intensities are transferred to a micro-computer and calculated concentrations are printed out on the X-ray console.

Technical data of Diano Automatic X-ray system type XRD-8500

- 8 Channels : SiO_2 ; Al_2O_3 ; Fe_2O_3 ; CaO ; MgO ; K ; Na ; SO_3
- Microprocessor control
- Microcomputer with two floppy-disc
- Sample presentation system - pneumatic
- X-ray tube with Cr anode (50KV; 40mA)
- Flow detectors (gas A Mn)
- Vaccum in analyzing chamber 200×10^{-6} mm H_2O

C EARTH GROUND

Grounding impedance is common for all electrical equipment raw material proportioning system and X-ray analyzers and has 0,3 to 0,4 ohm.

D MAINTENANCE OF INSTRUMENTATION AND COMPUTER SYSTEMS WITH X-RAY SPECTROMETERS

i/ Documentation :

Instrumentation group has all technical documentation supplied by manufacturers of instrumentation, control equipment, computers and X-ray spectrometers.

ii/ Tools, maintenance equipment and spare parts

Instrumentation group is well equipped with the tools, instruments and measuring equipment etc which are necessary for corrective and preventive maintenance.

Unfortunately, some of these instruments are very exploared and there are not a lot of important spare parts. There is not available actual instrumentation spare part list.

iii/ Corrective and preventive maintenance

Preventive maintenance in Narmada Cement Plant is poor. There are not preventive maintenance program, and only corrective maintenance and repair it's done.

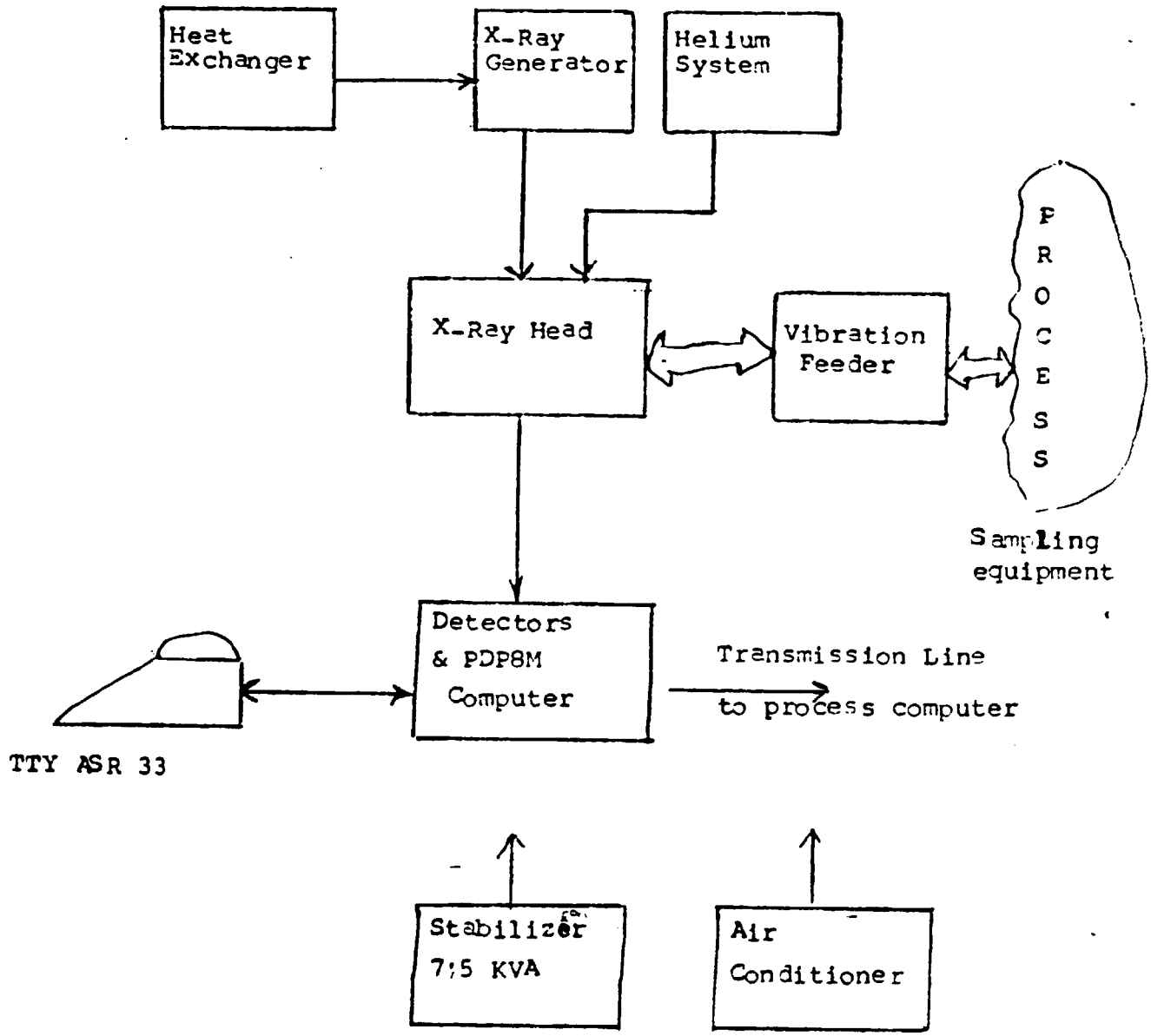

FIG.3: On-Line X-Ray Analyzer.

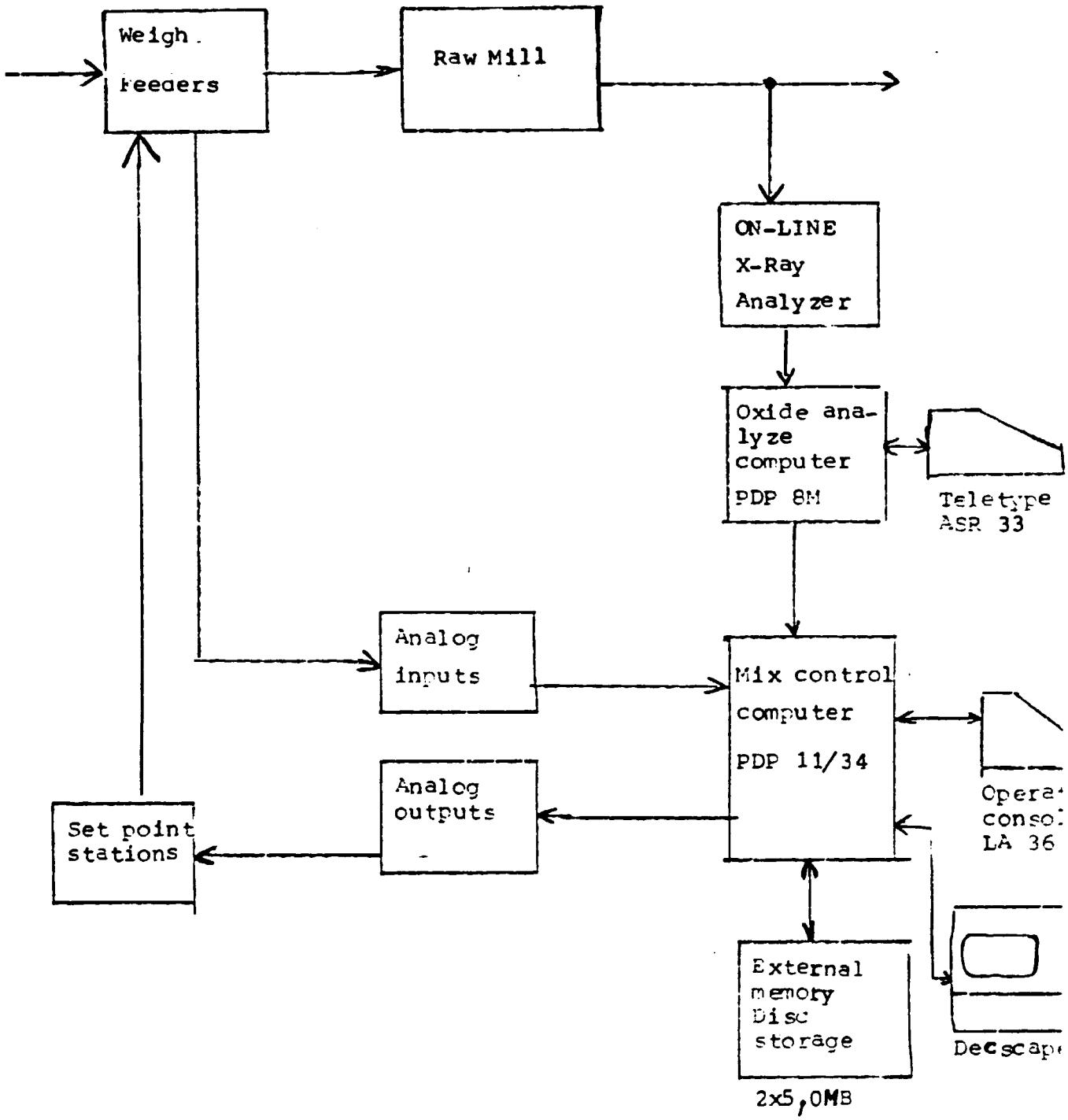

FIG.4. General view of Raw Material proportioning system

NARMADA CEMENT CO. LTD
JAFRA BAD GUJRAT

Names of the persons participated in discussions:

I: From Narmada Cement Co. Ltd. Jafrabad.

1)	Sh S.P. Nair	- General Manager (Works)
2)	Sh V.K. Budhwar	- Manager (Engineering)
3)	Sh V.M. Nene	- Manager (Production)
4)	Sh H.S. Patel	- Dy Manager (Works)
5)	Sh P. Modi	- Dy Manager (E&I)
6)	Sh S.V. Vikhe	- Instrument Engineer.

II: From MCE

1) Sh S. Chaterjee

2) Sh Rajendra Singh.

III : From UNIDO

Mr. J. Konieczny - Expert in Maintenance of Advanced Instruments and Electronic Control circuits.

Programme of activities during visiting:

1. Appointment with General Manager, Production Manager, Dy Mgr Electrical & Instrumentation and Instrumentation Engineer.

2. Acquainted with production line, machinery, power supply system and Motor control center.

3. Acquainted with instrumentation, analog control loops, raw material proportioning on-line system, off-line X-ray spectrometer and organisation of Instrumentation Group.

4. Technical discussion with Instrumentation Engineer regarding the details of maintenance of instrumentation and control equipment as well as X-ray spectrometers, computers and peripherial equipment.

5. Lecture on the subject of X-ray spectrometry, quality control systems and maintenance of this equipment.

6. Final discussion with officials Narmada Cement Ltd basic on observation during visiting the plant. Suggestions and recommendations conserning with maintenance and purchase new equipment, instruments and starting-up on-line Raw Mix proportioning system and utilization of off-line X-Ray spectrometer.

3. ACC - GAGAL CEMENT WORKS BARMANA (HIMACHAL PRADESH)

ACC - Gagal Cement Works is situated at about 18 km of Bilaspur Distt (Himachal Pradesh). The plant is single line ~~of~~ one dry process kiln with MFC calciner designed to produce 5.6 lakh tonnes per year cement. Programmable controllers, alarm annunciation systems, weigh feeders, field conventional instruments monitoring equipment and uninterruptible power supply systems have been supplied by Debikay Electronics (Allen-Bradley), Siemens, ECIL, Jonson & Nichalson (Karl Schenck), Instrumentation Ltd., Larson & Toubro, Toshniwal and NELCO. The important information gathered during the visit shown in attachment.

The plant has A/C Centralized Control room for raw mill, blending and storage, coal mill, kiln, clinker transport and cement mill etc. All programmable controllers, DC drives and uninterruptible power supply system panels of the plant have been grouped up and kept in centralised panel room. I/O rack of programmable controller and weigh feeders panels also have been grouped up and kept in different A/C rooms near to the different sections, since they found it convenient to analyse and rectify any faults whenever the panels behave erratically.

For crusher, SIMATIC-C_1 has been used for sequencial starting and stopping and SIMATIC-MS_3 system for fault monitoring. For other sections of the plant Allen-Bradley Programmable Controller- 1774 System has been used.

Instrmentation at raw mills and cement mills is very poor and plant does not have any control loops. The kiln section comprising preheater, precalcinator (MFC), kiln, grate cooler and coal mill has been instrumented along with analogue control loops using PI Controllers.

7 OBSERVATIONS

1. Many instruments in Central Control Room do not work.

2. Lack of proper instrumentation. Many modifications of analog control loop, control system and instrumentation equipment have been carried out. While wiring many loose ends are left unconnected.

3. Nuclear weigh feeders do not work satisfactorily.

4. New schenck weigh feeders for kiln feed and coal feed have not got provision for calibration test with material (check-weigh bin connected with weigh feeder for calibration test).

5. Kiln feed weigh feeder dosing valves of electrical actuators do not work properly.

6. TV camera of burning zone do not work.

7. Lack of two colour pyrometer at burning zone.

8. Lack of analog control loops at the Raw Mills.

9. Raw mills and cement mills are controlled by mill operator only by local switches.

10. Uninterruptible power supply for PC Motor Control System is not working properly.

11. PLC motor control system for the Cement Mills and Packing Plant has not yet been commissioned.

RECOMMENDATIONS AND REMARKS

1. Nuclear weigh feeders should be replaced by conventional normal type.

2. Electrical actuators of kiln feed W.F. should be replaced by either hydraulic or pneumatic linear type one.

3. TV camera to kiln burning zone can be put into operation after carrying out suitable modifications in brick lining in kiln hood and camera system should be repaired.

4. Two colour ratio pyrometer to measuring kiln burning zone temperature should be installed

5. Analog control loop for total raw mill feed controlled by bucket elevator load with correction from acoustic level, is provided but not installed and should be done at the earliest.

6. Uninterruptible power supply for PC motor control system should be repaired and put on normal operation. Though presently voltage stabilizer is there, the same is not able to control when the voltage fluctuates beyond $\pm$ 10% which normally is the case in this plant.

7. Preventive maintenance schedule for instrumentation and control system should be elaborate and implemented properly.

ACC GAGAL CEMENT WORKS

BARMANA (HP)

TECHNICAL DETAILS :

A MOTOR CONTROL SYSTEM

Centralised motor control system has 4 programmable Controllers from Allen & Bradley (type 1774-RP3) and divided in following parts :

PC "A"	Raw Mills
PC "B"	Homogenization Silos, Kiln feed and kiln
PC "C"	Coal mill and clinker cooler
PC "D"	Cement mill and packing plant

These PC's are installed in Central Control Room.

PC"A" has 8 k bytes core memory and 7 remote rack I/O scanner modules connected to CPU by teletransmission line.

PC"B" has also 8 k bytes core memory and 7 I/O racks modules.

PC"C" is equipped with 4 k bytes core memory and 3 I/O rack scanners

PC"D" for cement mills and packing department Motor Control panels are not connected to the process.

These PC are equipped with different type inputs and outputs like :

- AC 120 V 8 inputs
- DC 24 V 8 inputs
- AC 120 V 8 outputs

AC 120 V outputs are supplied by remote power supply 2A, 120 V.

Programme devices which can be used to the introductory programming, documentation, maintenance, trouble shooting and updating establish intelligent industrial terminal with CRT Screen and Keybord. For reloading control programmes, used digital tape recorder. Unfortunately, there is no printer to print out programmes to obtain updated documentation.

B POWER SUPPLY AND GROUNDING OF PLC'S SYSTEM :

Power supply condition in Gagal Cement Works forced application uninterruptible power supply and stand by constant voltage stabilizer alongwith insolating transformer. Unfortunately uninterruptible power supply from NELCO - India does not work properly and is used like stand by.

Electronic constant voltage stabilator accept input voltage variation ± 10%. because of output voltage fluctuations when voltage variation more than 10% and trip PLC's system.

Grounding system common for all electrical and control equipment.

C MAINTENANCE OF INSTRUMENTATION AND CONTROL EQUIPMENT

1. Documentation :

Instrumentation group has only standard technical documentation supply by producers of these equipment and designers of instrumentation and control systems, additionally a lot of modification

and change in control system and instrumentation force execution for new sets of technical documentation.

2. Maintenance tools and spare parts :

Instrumentation Laboratory is well equipped with maintenance tools, measuring equipment etc. which are necessary to repair and preventive maintenance. There are also many spare instruments, transmitters etc.

However, there are not some very important spare modules i.e. CPU modules for PLC and others more complicated modules.

3. Maintenance :

In Gagal Cement Works, plant has done only corrective maintenance. There are not preventive maintenance schedule and this type of maintenance is neglect.

ACC - Gagal Cement Works

ANALYSIS OF KILN BREAKDOWN DURING JANUARY - NOVEMBER 1986

Table 2

Month	Mechanical		Electrical		Instrumentation		Other		Total	
	Number	Hours	Number	Hours	Number	Hours	Number	Hours	Number	Hours
I 86	6	49.92	6	16.50	9	3.83	8	161.67	29	231.92
II 986	8	37.08	5	4.25	6	6.08	8	122.59	27	170.0
III 86	7	20.75	10	23.66	12	7.00	7	5.42	36	56.83
IV 86	7	21.25	3	2.33	2	3.25	5	166.33	17	193.16
V 86	5	16.08	5	5.75	2	1.00	8	145.75	20	168.58
VI 86	8	48.25	7	9.33	3	2.92	5	51.25	23	111.75
VII 86	7	61.92	6	6.00	2	2.60	4	362.56	19	433.08
VIII 86	2	14.75	9	14,16	5	13.16	15	189.93	31	232.0
IX 86	-	-	4	13.50	4	5.00	10	63.00	18	81.50
X 86	3	24.08	5	3.25	8	9.42	9	173.41	25	210.16
XI 86	7	56.25	6	4.75	6	4.08	9	62.42	28	127.50
Total	60	350.33	66	103.48	59	58.34	89	1504.33	274	2016.48

Kiln stoppage by reasons :

1. Mechanical 17.37%
2. Electrical 5.13%
3. Instrumentation 2.89%
4. Other (refractory compressors water) 74.60% or 0.79% yearly hours

Kiln run factor 72.58%

ACC - GAGAL CEMENT WORKS
BARMANA (H P)

Name of the persons participated in discussions :

I	From ACC - Gagal Cement Works		
	1.	Sh S B Agrawal	General Manager
	2.	Sh M S Gilotra	Dy General Manager
	3.	Sh Prem Sagar	Master Burner
	4.	Sh S K Anandan	Asstt Instrument Engineer
	5.	Sh B K Basu	Asstt Instrument Engineer
II	From NCB		
	1.	Sh Rajendra Singh	
	2.	Sh A. V. S. Rao	
III	From UNIDO		
	Mr J. Konieczny		Expert in Maintenance of Advanced Instruments and Electronic Control Circuits.

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

ANNEX - I

List of the most usefull tools and instruments for the Instrumentation Workshop.

I. Sets of electrical /electro-mechanical/ tools.

2. Set of spanners.

3. Adjustable spanners.

4. Tongs, pens, etc.

5. Analog multimeters.

6. Digital multimeters.

7. Double channels oscyloscop min. I5 Mhz /IM 3226/

8. Field calibrators /0-25mA , 0-I5V /

9. Digital thermometer

I0. High temperature indicator.

II. Vibration measuring instrument.

I2. Hand Tachometer with contact adaptor /TH-20II/

I3. Automatic Voltage Stabilizator 0-300 V.

I4. Regulated DC Power Supply / 0-5A , 0-60V /

I5. DC Power Supply 5V, I2V, -I2V, 24V, -24V .

I6. Autotransformator 2KVA.

I7. Adjustable Resistors.

I8. Higrometer.

I9. Logic Probes.

20. Soldering Irons.

2I. Soldering Devices / [illegible] /.

22. Dead weight pressure gauge tester.

23. Precise resistors / Type EL 55-05 or eq./

24. Thermocouple test set.

25. Resistance thermometer test set.

26. Pt-ICO simulator.

27. Digital calibrator.

28. Portable gas analaser. CO, O_2 .

29. Frequency generator 50Khs.

30. Universal Frequency Counter.

31. Special maintenance and service equipment for computers , peripherial equipment , PLCs , X-ray spectrometer etc.

ANNEX - 2

Work Programme of Mr JAN KONIECZNI

DP/IND/84/020/II-28 - Expert in Productivity Improvement through Maintenance of Advanced Instruments and Electronic Control Circuits. as part of NCBM Team on Prodctivity Enhancement and Modernisation Programme.

FIRST MISSION OF TWO MONTHS DURATION.

DATE	ACTIVITY
22-23 October 1986	UNDP Mission formalities
24 October 1986	Briefing by UNDP Project Director and Chairman and Director General NCB
24 October 1986	Discussion with CRI Director
24 Oct. to 14 Nov. 1986	Visit to NCB-B. Technical discussions with NCB officials on PEP activities undertaken. Acquaintance with Process Control Instrumentation and Automation and Maintenance aspect of Indian Cement Industry. Talks on Maintenance of advanced instruments and electronic control circuits and the state of art technology in plant control and monitoring.
15 Nov. to 18 Nov. 1986	Visit to SHREE CEMENTS LTD - BEAWAR Study of maintenance and trouble shooting of advanced instrumentation and motor control system using programmable logic controlers as well as other electronic control instruments. Interaction with plant officials regarding maintenance problems of advanced instruments and instalation of quality control system with X-ray spectrometer.

DATE	ACTIVITY
I9 Nov. to I Dec. I986	Formulation of observations and recommendations based on the visit to SHREE Cements Ltd and preparation of report at NCB-Ballabgarth. Technical discussions with NCB specialists.
2 Dec. to 5 Dec. I986	Visit to NARMADA CEMENT CO LTD JAFRABAD -GUJARAT. Interaction with plant officials to identify the major problems of maintenance and trouble shooting of advanced instrumentation , X-ray analyzer /off-line/, Raw Material Proportioning system with on-line X-ray analizer and process computer and other electronic control instruments.
6 Dec. to 8 Dec. I986	Interaction with NCB counter parts. Finalisation of the PEP team's report based on the visit to NARMADA Cement Co Ltd.
9 Dec. to I3 Dec. I986	Visit to ACC GAGAL CEMENT WORKS - BARMANA. Study of maintenance and trouble shooting of advanced instrumentation and motor control system using programmable logic controlers and interaction with plant officials regarding maintenance problems of electronic instruments and systems.
I4 Dec. to I5 Dec. I986	Formulation of observations and recommendations based on the visit and preparation of report at NCB.
I6 Dec. I986	Interaction with NCB counterparts and discussions on the outcome of the mission. Finalisation of the mission.
I6 Dec. I986	Debriefing with Project Director

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