Development
Of
Condition Based Maintenance
For
Coal Handling Plant
Of
Thermal Power Stations

By:
Makarand M. Joshi
Email: makarandj@hotmail.com

1.0 Abstract: -

In the thermal power plants maximum requirements of fuel is a coal. The handling of this fuel is a great job. To handle the fuel i.e. coal, each power station is equipped with a coal handling plant. Almost all CHP these days implies Reactive Maintenance with support of preventive maintenance. Under the current business environment, cost competitiveness, effective maintenance management has been accepted as the key to corporate strategy for reduced costs. This has led to integration of maintenance management function with production and business problems, not just equipment problems. The failures of equipments have led to high maintenance and operation costs. Implementation of modern concept of Condition Based Maintenance can appreciably reduce maintenance costs and enhance reliability of machine performance.

The concept of condition-based maintenance, discussed in this paper for Coal Handling Plant is to offer significant benefits. The system introduced in this paper will measure and detects the onset of a degradation mechanism thereby allowing casual stresses to be eliminated or controlled prior to any significant deterioration in the component physical state. Guidelines for implementation of CBM in CHP are also discussed in this paper.

2.0 Introduction: -

CBMS or Predictive Maintenance methods are an extension of preventive maintenance and have been proved to minimize the cost of maintenance, improve operational safety and reduce the frequency and severity of in-service machine failures. The basic theory of condition monitoring is to know the deteriorating condition of a machine component, well in advance of a breakdown.

There are varieties of critical equipments in Coal Handling Plants. These components require routine inspection to ensure their integrity. The purpose of the inspection is to identify any degradation in the integrity of the systems during their service life and to provide an early warning in order that remedial action can be taken before failure occurs. Assessing the condition is necessary to optimize inspection and maintenance schedules, of Coal Handling Plant to make decisions and to avoid unplanned outages.

3.0 Importance of CBM for CHP: -

To maintain an efficiently operating unit and avoid failure of critical equipment, it is necessary to maintain the critical parts of that equipment. The effect of planned maintenance is depending upon the methods used for maintenance. The combination of corrective preventative and condition based maintenance will required to apply for Critical Equipments. This type of maintenance policy and strategy will improve performance of CHP through availability of Critical Equipment.

The basic layout of Coal Handling Plant is shown by block diagram. (See Fig. No 1) the coal is unloaded at unloading station and transported by conveyors to crushing and screening plant via transfer house. After crushing required quantity of coal is transported to bunker via transfer house and remaining coal is stored in stockyard. This coal is reclaimed as per requirement.

There are different streams for transporting of coal. The streams are operated as per requirement. Some of the CHP's are now days are operating beyond their design lives. Working conditions in CHP are dusty, dirty and often wet conditions. So there is a constant quest to improve machine uptime and avoid unplanned maintenance. A plant, which supply of coal to boilers having capacity of 750 tones per hour failed to fulfill need will loss generation of 0.6 MU for one hour. This cost 1.20 Core of Rupees.

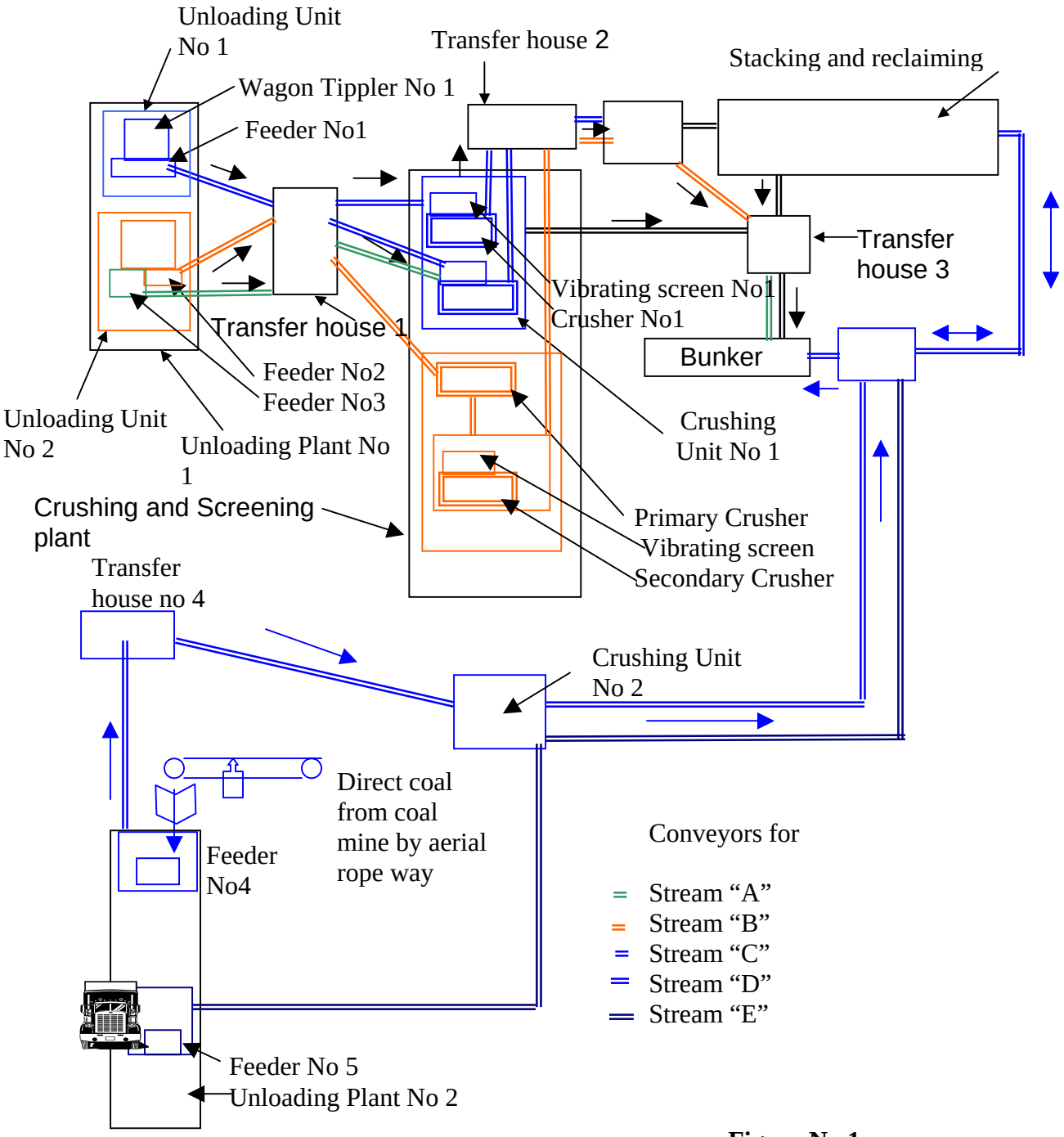

Figure No 1

4.0 <u>Objectives of CBM</u>: -

The main objectives of CBM for CHP should be as follows

1. Establishing an alarm level based on the variations of a physical parameter like vibration, power consumption, temperature etc.

2. Prediction of impending failures of critical plant components like Crusher Rotors, Conveyor Pulley Shafts, in real time resulting in enhanced safety, operational reliability, availability, and maintainability.

5.0 Condition Monitoring Implementations: -

The steps in implementing CBM are

1. Divide Plant For Ease Of Maintenance
2. Detection Of Physical Parameters
3. In Service Examination By Using NDT
4. Analysis or Fault Diagnosis
5. Correction.

5.1 Divide Plant For Ease Of Maintenance: -

Coal handling plant should be divided into five [1] sections for ease of CBM.

- Unloading Units
- Feeding Units
- Crushing and Screening Units
- Stacking and Reclaiming Units
- Bunkers

5.1.1 Unloading Plant: -

These comprise of unloading units. The types of unloading units are depending upon the transport mode of coal.

The transport mode of coal is as follows.

1. Aerial ropeway
2. Railway
3. Road ways
4. Ship

5.1.2 Feeding Plant: -

This comprises of various types of feeders. The use of dozers and mobile equipments are done for feeding purpose. The efficient and economical storage, movement and control of large tonnage coal handling installations, coal car unloading, storage, reclaim system depend on the proper application of feeders.

The various types of feeders being used in coal handling plant are:

1. Apron feeder
2. Belt feeder
3. Rotary feeders
4. Reciprocating feeders
5. Screw feeders
6. Revolving disc feeders
7. Vibrating feeders

5.1.3 Crushing and Screening Plant: -

This comprises the belt conveyors within the crushing and screening plant, the crushers and the screens. Coal from the mines varies to great extent in its size. So it is required to crush upto required size. For this various types of crushers are used. There are four basic ways to reduce material: by impact, attrition, shear or compression. All crushers employ one, or a combination of these four methods. These ways are given below

1. Impact
2. Attrition

3. Shear
4. Compression

The coal, which of required size, is not required to crush. To avoid entry of proper size coal in crusher the screens are used.

5.1.4 Stacking and Reclaiming Plant: -

After unloading of the coal, required quantity of coal is to be bunkered. The remaining quantity of coal is to be required to store. This store coal can be reclaim as per requirement.

5.1.5 Bunker: -

Generally bunkers are located in boiler house of the power station. The bunkers are equipped with bins. These bins are feed by mobile conveyors or travelling tippers. The bunker slots are secured by grates and are covered with trailing belts.

5.2 Detection Of Physical Parameters: -

The basic theory of condition monitoring is to know the deteriorating condition of a machine component, well in advance of a breakdown. There are many parameters that can be measured, trended and analyzed to detect [2] imminent failure or onset of problems. It involves measuring physical parameters level at marked locations on each machine on a regularly scheduled basis. The objective is to reveal significant increases in a machine's parameter level to warn of developing problems Common among them are:

1. Vibration
2. Lube oil analysis including wear debris analysis
3. Additionally, operational characteristics such as Coal flow rates; Conveyor speed and so on can also be monitored to detect problems.

5.2.1 Vibration Monitoring: -

Each machine in the best of operating condition will have some vibration, which may be regarded as normal or inherent. Whenever machinery vibration increases beyond safe limits, the usual reasons are unbalance, misalignment, worn gears or bearings, looseness, etc.

Mass unbalance, bowed shafts and cracked shafts, these being amongst the most common rotor-dynamic faults within a rotating machines. Vibration response measurements yield a great deal of information concerning any faults within a rotating machine. Critical machines of Coal Handling plant like Crushers can be continuously monitored by providing of permanently mounted vibration transducers.

5.2.2Temperature Monitoring: -

The temperature limit [3] of a component is defined as the peak temperature where the material characteristics of a component are still within the range, which allows a full satisfactory function and structural integrity. Whenever this limit increases, beyond safe limit, the common reasons are improper bearing lubrication, increase friction in the gear mesh, in the bearings, at the seals and hydrodynamic friction between the lubricant and the moving components.

In Coal Handling plant by providing of permanently mounted temperature sensors can continuously monitor Gear-Box of Critical Conveyor, bearings of Crushers. The use of infrared cameras or installing thermocouple sensors in the housing of a bearing and measuring temperature changes within the bearing or lubricant allows problems to be recognized early (potential failure).

5.2.3 Other Physical Properties Monitoring: -

Generally each machines has characteristic properties like power consumption, coal flow rate and speed, which may be regarded as normal or inherent. The reasons for crossing the limits of these properties are various for each machine. Reduction in the speed of conveyor with respective power consumption may be due to fluid coupling oil seal damage. The change in oil properties of gearbox, fluid coupling will clear indicate any physical damages.

5.3 Analysis or Fault Diagnosis: -

Fault diagnosis is a subject too wide-ranging to allow a comprehensive coverage of all of the areas associated with this field. Analysis helps to pinpoint specific machinery problems by revealing their unique characteristics. Accurate diagnosis can be made when the fundamental of each component is known.

5.4 Corrections: -

Corrective action is taken after specific problem has been detected and identified by planning and scheduling all activities to ensure that machine downtime is kept to the absolute minimum inspection results.

6.0 P-F Curves: -

Condition based maintenance rely on the fact that many failures do not occur instantaneously, but actually develop over a period of time. If evidence can be found that this failure process is under way, it may be possible to take action to prevent failure. P-F Curve means potential failure curve, which helps the maintenance department to correct the fault, before it becomes more serious. The P-F curve shows [4] how a failure starts, deteriorates to the point at which it can be detected (the potential failure point "P"), if it is not detected and corrected, continues to deteriorate - usually at an accelerating rate - until it reaches the point of functional failure ('F') The P-F interval can be known as the "Lead Time To Failure." See Figure No 2.

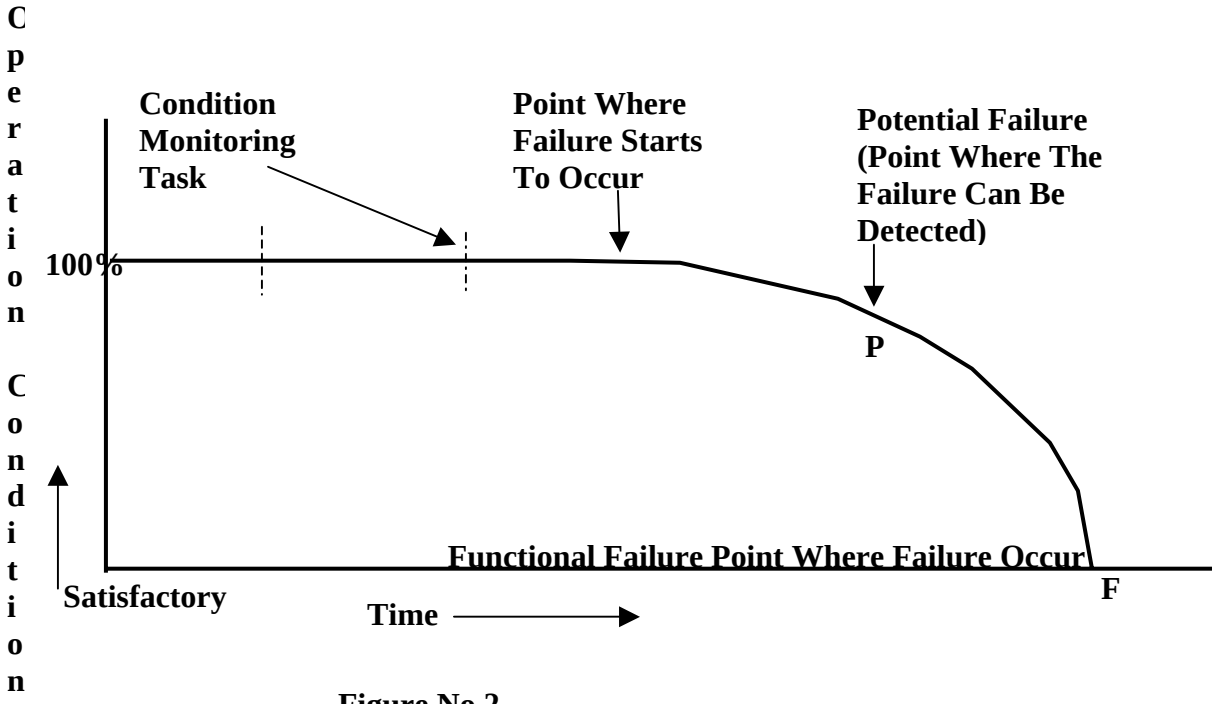

Figure No 2

7.0 Condition Measurement Techniques: -

The "condition" being measured can take a variety of forms. Any condition that shows a change, as the health of the spare deteriorates, can be used. It is important to locate the area of equipment where the condition measured will help to correct analysis. The correct analysis [5] of condition will help for exact fault detection. Table No 1 will guide condition measurement for coal handling plant.

Measurement		Equipment	
Parameter	**Instrumentation**	**Positions**	**Description**
Vibrations	Vibration analyzers/data collectors, hand held overall meters	Transducer placed in path of vibration transmission i.e. bearing housings	Crushers & Pulley Bearings, Gearbox, Crusher Rotors
Vibrations	Detection meters, Shock pulse etc.	As close to source of vibrations.	Crushers & Pulley Bearings, Gearbox, Crusher Rotors
Temperature (Contact)	Thermocouples, RTD	Surface or internally mounted	Crushers & Pulley Bearings, Gearbox
Temperature (Non-Contact)	Infra red cameras, Pyrometers, Laser Thermometer	Surface	Crushers & Pulley Bearings, Gearbox
Lubricants (Condition)	Analytical lab or Portable lab kit	Any lubrication sample	Gearbox, Fluid Couplings
Lubricants (Wear Debris)	Spectrographic analysis, On-line systems Ferrography	Wear Debris in lubricant used between wear surface via magnetic plugs	Gearbox, Fluid Couplings
Speed and current Relations	Taco generators with current transformer	Mounted on shafts	Fluid Couplings
Current	Load cell with Current Transformer	Below the conveyors and in panels	Electromagnetic vibrating feeders

Table No 1

8.0 In Service Examination By Using NDT: -

The periodic inspection [6] should be carried of critical equipments by using NDT. It is essential to identify the critical areas where failures are likely to occur and select suitable NDE techniques for detection of such failures. Based on design criticality, past experience and previous failure information, suitable approach in inspection methodologies is to be adopted. A thorough knowledge of each NDT method is required to ensure the correct selection of the appropriate method for each application.

Ultrasonic inspection can be used to detect internal flaws such as cracked shafts, common rotor-dynamic faults within rotating machines. To detect surface flaws in transfer chutes is simple way by using ultrasonic technique.

Airborne Acoustic Condition Monitoring can be used for Conveyor Gearbox. Acoustic emission monitoring is useful for conveyor structures.
Table No 2 will guide for using NDT for coal handling plant.

Measurement		Equipment	
Parameter	**Instrumentation**	**Positions**	**Description**
Thickness	Ultrasonic thickness gage like " Nova TG2"	Surface	Transfer Chute Liners, Grinding jib of crushers, Conveyor structures etc.
Thickness	Digital Radiography	Surface	Transfer Chute Liners, Grinding jib of crushers, Conveyor structures etc.
Flaw	Ultrasonic Flaw Detector like "Quantam TE"	Surface	Crusher Rotors; Jack shaft, Grinding jibs; Suspension Bars, Arms, Sprocket Tiers etc.
Flaw	Acoustic Impact Technique	Surface	Crusher Rotors, Bearings
Flaw	Magnetic Flaw Detector like "MD20 Wire Rope Tester"	Surface	Wire ropes of Aerial Ropeway

Table No 2

9.0 <u>Conclusions</u>: -

CBM it will allows planning shutdown before severe damage occurs and reduce reactive maintenance practice.
The transition to CBM for CHP will require a substantial investment. The return on this investment will be dependent on the effectiveness of its implementation and the commitment of all personnel.
Cause of failure can be analyzed
Help for planning the requirement of long lead items.
Effective use of CBM will offer benefits in plant availability, optimized use of resources, reduced downtime, which reduce railway demurrage and further insure smooth and interrupt coal flow for boilers.
The knowledge of machine condition and their time dependent behavior will be the basis of efficient condition monitoring for CHP.
CBM will successfully diagnoses and locates faulty operation conditions at an early stage in order to prevent severe failures and will enable predictive and condition-oriented maintenance

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