
Research on Equipment Management Innovation of BX Steel

Abstract

At present, equipment maintenance and management has already become a marginal, comprehensive and systematic subject. Various kinds of Equipment Maintenance Management Theory are rapidly developing, in which Equipment Comprehensive Engineering, State Repair, Production Maintenance and Life Cycle have provided the theoretical basis for the equipment management solution established by the global enterprises according to their own characteristics.

BX Steel all along push forward precaution maintenance that taken the Point Inspection as core, and gradually change it into collectivity production maintenance. BX Steel never takes the Foreseen Maintenance as an important management way to push and guide our equipment management. So how to use Foreseen Maintenance according to our actual conditions and how to continuously perfect our equipment maintenance solution are very important to our equipment management.

Firstly, this article combines the importance of the equipment management of iron and steel produce enterprises with our actual condition to research how to establish the innovation mode for equipment foreseen maintenance management according to Foreseen Maintenance Theory and WISCO Any Point Controlled Theory; Secondly, it takes the 1880mm production line of our hot rolling mill as experimental unit to design a foreseen maintenance solution for equipment; Thirdly, it suggests the detail measures for executing the equipment foreseen maintenance solution; At last, the article provides the research directions for equipment maintenance according to actual developing condition of BX Steel.

By establishing the foreseen maintenance mode, it will make an effective roll to the improvement of technical quality of operators and maintenance personnel, the decrease of equipment mistakes rate, the increase of equipment availability, and the enhancement of production capacity.

Key words: Equipment Management, Foreseen Maintenance,
Status Monitor

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Chapter I Preface

1.1 Background and Purpose of Research

1.1.1 Background of research

(1) Continuously perfecting the equipment management is the important part of enterprise management.

Proved by the practice of equipment management of modern enterprise, to enhance the enterprise management is aid to improve the production efficiency, help enterprise to win the better economic benefit, stimulate to make progress, accelerate modernization, and upgrade competitiveness of the enterprise.

(2) The theory of World Maintenance Management provided an theory basis for the equipment maintenance solution established by enterprise.

After finished the livelong breakdown maintenance era, the history of the world maintenance management changed greatly. Different kinds of theories for equipment maintenance management come into being and develop rapidly. So the equipment maintenance

management has already become a margin, comprehensive and systematic subject.

(3) Requirement for improving the equipment management of BX Steel

BX Steel all along takes the Point Inspection System as the core precaution maintenance method. With perfect and execution of the system, it ensures equipment status and capacity can satisfy with the requirements of production scale expansion and production load increase. Along continuous developing of our enterprise, BX Steel should gradually change the precaution maintenance mode into foreseen maintenance mode, and try to improve the management solution of equipment maintenance. The above-mentioned content are very important for upgrading the equipment management of BX Steel, and which is also the important background and objective precondition for research of this article.

1.1.2 Purpose of research

Firstly, choice of the topic starts from the type, scale and characteristics of native iron and steel enterprises, which combines the factual condition of the equipment maintenance management of BX Steel to put forward the correction solution of equipment

maintenance fitted for BX Steel. The maintenance solution makes a very important roll for improving the equipment management level of BX Steel, and which also provide a practical and maneuverable management solution for improving the equipment comprehensive efficiency of iron and steel enterprises.

Secondly, according to the Foreseen Maintenance Theory and a series of problems found after setting of the Point Inspection & Periodical Maintenance System, some correction measures are provided to guarantee the stable equipment running and the superior quality production.

1.2 Thread and Approach of Research

1.2.1 Thread of research

Firstly, this article put forward the meaning of the Foreseen Maintenance by research and analysis on the theory of the Equipment Management and Foreseen Maintenance. Afterward it analysis the shortages of the Equipment Maintenance System and the advantages of the Foreseen Maintenance combined with present conditions of BX Steel, and to show the urgency and necessity for executing the

mode innovation of maintenance management. At last, it provides the design solutions and execution measures for Foreseen Maintenance of BX Steel.

1.2.2 Approach of research

To research the meaning of Foreseen Maintenance by cases analysis approach. According to the Foreseen Maintenance provided by the paper and the Any Point Controlled Theory of WISCO, some real cases are stated to show the feasibility and the necessity for executing the mode innovation of equipment maintenance, and the improvement direction for equipment management of BX Steel.

1.3 Paper Structure

Structures of the paper are made up of 5 chapters stated as follows:

Chapter I Preface

This chapter states the research background and purpose of equipment maintenance solution of BX Steel, i.e. continuously perfecting the equipment management is the important point of enterprise management, and the theory of World Maintenance

Management provide an theory basis for the equipment maintenance solution established by enterprise. Thereafter combines the requirement for improving the equipment management of BX Steel to show this paper's topic. Purpose for research is to provide guarantee for improving the equipment maintenance level, running efficiency and stable production.

Chapter II Management Theory Summary for Equipment Foreseen Maintenance

Firstly, this chapter shows the connotation and task of equipment management. And then introduces the connotation for the theory of Equipment Foreseen Maintenance Management. At last, it states the meaning for Foreseen Maintenance.

Chapter III Actuality Analysis on Equipment Maintenance Management for BX Steel

Firstly, this chapter introduced the general situation and the production equipment characteristics of BX Steel. On the basis, it made an analysis on the management mode for equipment maintenance of BX Steel. At last, it showed the feasibility and the necessity for executing the mode innovation of equipment maintenance of BX Steel according to the Any Point Controlled Theory of WISCO.

Chapter IV Solution Design and Execution for Foreseen

Maintenance of BX Steel

Firstly, the chapter made a general design for the Foreseen Maintenance Solution, which introduced the solution buildup, on-line monitor solution and the system function characteristics. Then it stated the execution for the Foreseen Maintenance Solution of BX Steel.

Chapter V Conclusion and Prospect

This chapter summed up the research results and conclusion of this paper, and pointed out next step research direction that need to be developed in the future.

Chapter II Management Theory Summary for Equipment Foreseen Maintenance

2.1 Connotation and Meaning for Equipment Management

The equipment is not only the important part of fixed assets of an enterprise, but also the major symbol of the techniques level. Furthermore, they are the substance technical basis for the normal production and market competition. So how to efficiently use and manage the equipment is very important for the modern enterprise management.

2.1.1 Connotation for equipment management

Equipment management is also called equipment engineering. It takes the production and manages aim of enterprise as the basis, and the efficiency improvement of equipment as the purpose. Through the researching and investigation, it used many kinds of technical, economic and organized measures to synthetically manage the substance movement form and value movement form of all the equipment during the equipment life cycle ^[1]. It can manage the whole life cycle of the equipment from the programming, design,

trail-manufacture, manufacture, type selection, installation and commissioning, use and running, maintenance and repair, revamp, and update to the final reject^[2].

2.1.2 Meaning of equipment management

Equipment management acts a very important roll and position in an enterprise determined by the modern enterprise production activity. Only the modernized equipment and the modernization of the equipment management can get the high efficiency production and high benefit production^[3].

(1) Equipment management is the important guarantee for normal equipment running.

During modernized production, the quality of production equipment directly affects the production task to be finished and the economic benefit of an enterprise. Thus correct use, well maintenance, repair, and good running state for the equipment are the important condition to guarantee the normal production. And it is also the equipment guarantee for getting optimal economic benefit of an enterprise. Therefore, equipment management can directly affect the correct

exertion of technology level and technical status. Only efficient and scientific equipment management and rapid reaction to the equipment problems can guarantee the stable running of the equipment ^[4].

(2) Equipment management is the important guarantee for improving the maintenance quality.

Equipment manage level directly affects the maintenance time and the quality of the equipment. Adopting modernized manages methods and scientific organization can guarantee the quality, shorten the job limits and improve the equipment availability.

(3) Equipment management is the important guarantee for improving the economic benefits.

Metallurgical enterprise is the capital concentrated type enterprise. The equipment investments are very tremendous, which occupied about 60-70% of the equipment (exclude the industry building). Spare parts, wear parts and maintenance materials needed by the equipment occupied 40% in the total flow fund of enterprise. And equipment maintenance expenses are considerable tremendous. So equipment

maintenance management is also the important guarantee for the economic benefits of an enterprise.

2.1.3 Content and task for equipment management

(1) Content for equipment management

The basic task for equipment management is the correct management and usage of the equipment. Equipment movement can be two types: one is substance form, another is value form. The two forms made up of two managements: technology management and economy management. Technology management include prophase management; equipment assets management; equipment use and maintenance management; timing maintenance, state monitor, diagnostic analysis, and generation of the repair plan; revamping and update management. Economy management include economic and technical analysis and evaluation to the investment plan; economic life and depreciation of equipment; life cycle cost (LCC), life cycle benefits, comprehensive efficiency analysis of equipment; value system management of cooperated project; structure model and flow fund of spare parts.

(2) Task for equipment management

According to the principle of advanced technology and reasonable economic cost, correct choice can provide good quality and low cost equipment for enterprise; Enterprise should try to push the scientific equipment manages system, make use of modernized manages approach and self characteristics to service the improvement of the economic benefits; The sticking point for equipment management is correct use, well maintenance, precaution maintenance and improved maintenance to the equipment. The manage thoughts also should be changed from major maintenance to precaution maintenance, and try to decrease the emergency accident affected the normal running; Making good use, innovation, update and revamping to the present equipment, continuously improving the technology level, and producing in the optimal condition of substance and technology; Improving the equipment maintenance technology, studying and pushing forward the new technologies for equipment maintenance, and making good supply to the spare parts and wear parts; Good technical training on equipment manages and maintenance

should be made to the personnel, which can improve the technical quality and business level of all the equipment management personnel, and fit for the new requirement of equipment management.

Therefore, technology is the base, management is the measure, and economy is the aim. The management purpose of enterprise is to improve the economic benefit, and the equipment management should also service to the purpose. The meaning of equipment management is to use the most economical life cycle cost of equipment to create the optimal economical benefit. One side decreasing the cost by the comprehensive management of the whole life cycle, the other side try to improve the availability and working efficiency of equipment.

2.2 Connotation and Meaning of Equipment Foreseen Maintenance

2.2.1 Summary of Equipment Foreseen Maintenance

Advanced equipment need advanced maintenance technology, and even more need the advanced management mode. The present

equipment related with wide range of knowledge field has become a margin, comprehensive and systematic subject. The technology of equipment management include: operation research, logistics engineering, system engineering, comprehensive engineering, behavior science, reliability engineering, management science, engineering economy, man-machine engineering, etc. ^[2]

The evolvement history of world maintenance management (four phases) can enrich and perfect the equipment manages theory continuously.

(1) First generation : Breakdown maintenance phase (before 1950)

Characteristics: after broken to make maintenance, without broken without maintenance.

(2) Second generation: Precaution maintenance phase (1950-1960)

They include two systems:

□ Plan Precaution System presented by Soviet Union

Advantages: It can decrease the unplanned (failure) emergency stop, and eliminate the potential failure.

Shortage: It is not economic.

□ Precaution Maintenance System represented by the United States

Advantages: It can decrease the failure stop. After checking, the planned maintenance will decrease part of the blindness.

Shortage: It is limited by the checking methods and experience of personnel, so it can make the plan incorrect and the maintenance too much or incompletely.

(3) Third generation: Production Maintenance Phase (1960-1970)

According to the importance of the equipment, to choose the maintenance way. They include 4 maintenance methods: breakdown maintenance, precaution maintenance, improvement maintenance, and maintenance precaution.

(4) Fourth generation : Parallel phase for various of equipment management mode (From 1970 up to now)

□ Comprehensive Engineering of equipment

To take the most economical life cycle cost as the research aim, to research how to improve the equipment reliability and maintenance design, to improve the design quality and efficiency, to emphasize the design of the equipment and the information feedback of the use and cost.

□ Status Maintenance

The maintenance executed after obvious deterioration appeared on the equipment, moreover the status of deterioration is reflected by the status data changes of the monitored machine.

□ Overall Production Maintenance

It takes the highest overall equipment efficiency (OEE) as the purpose, and establishes the precaution maintenance of the whole equipment life. All the personnel from top management layer to the operators must attend the activities for plan, use and maintenance of equipment.

□ Maintenance taken the reliability as center ^[5]

It is emphasized to take the reliability and failure result of equipment as the major evidence to establish the maintenance strategy.

2.2.2 Connotation of Foreseen Maintenance

The Foreseen Maintenance of equipment status that takes the equipment state monitor as basis, takes the failure analysis and diagnostic result as evidence, and takes the foreseen state of

equipment as means is an increasingly mature equipment maintenance way. During recent scores of years, by combining the systematology, cybernetics, information theory, reliability theory, friction and abrasion theory, and behavior science with the equipment management practice, to create the new theory and new mode for equipment management, such as comprehensive engineering of equipment and Japan Total People Management (TPM). They bring the equipment management from the traditional way to the modernized way; Through applying the basic subjects that include Electricity, acoustics and thermology, failure physics theory and application chemistry into the control of equipment status information, to create the technology of equipment monitor and failure diagnostics, they push the equipment maintenance way to the precaution maintenance phase; By applying the systematology, cybernetics and modern optimization theory into the technical and economic comprehensive management to form a series of modern manages way of equipment, and then the personnel can predict and make a decision according to the experience. Therefore, the quantitative and scientific decision making will start. We can foresee the equipment management will fall into a new stage

of dynamic and optimized manages with the deep development of the computer management. Moreover, the wide applications of modern technical result are the headspring for continuously improving the management efficiency and benefit.

2.2.3 Meaning of Foreseen Maintenance

All the plants of BX Steel are pipelining operation, any equipment break down or failure will bring our enterprise into stop production and loss money. So we must monitor the important equipment, make Foreseen Maintenance, eliminate the hided defects and prevent the occurrence of the severe disaster results.

With the modernized equipment widely apply, and the Point Inspection and Periodical Maintenance System push forward in BX Steel, with ERP information system completely come on-line running, the reform to equipment maintenance system is imperative under the situation.

(1) Equipment status monitor is the requirement of the system reform of equipment maintenance.

During the flow industrial production, breakdown maintenance certainly will cause the tremendous economic loss, which can't

be applicable to the key production line and the important equipment for a long time. At present, the common routine inspection system can't solve the conflicts between the maintenance overmuch and the maintenance lack. The system cost too much maintenance costs, which is neither economical nor reasonable. So real time state monitor, deterioration trend control and status maintenance of the equipment are an important way for improving productivity, which are the requirement of modern equipment management. Nevertheless, the technical supports and state monitor measures must be taken to the Foreseen Maintenance and Status Maintenance. Only the present Point Inspection means can't satisfied with our requirements.

- (2) Equipment status monitor can efficiently decrease the catastrophic failure.

For our important production equipment, we must strengthen the early phase diagnostic and precaution, and improve the reliability and safe running rate. Execution of equipment state monitor and diagnostic technology can diagnose and predict the equipment failure, and timely and accurately inspect the

potential hidden troubles and failure portent. Accordingly, we can efficiently decrease failure rate, catastrophic failure and stop accidents to guarantee the safe and stable running.

- (3) Equipment status monitor can decrease the equipment maintenance costs.

Not only failure rate, but also equipment maintenance costs must be decreased, and then the economical running of equipment can be guaranteed. By the equipment status monitor and diagnostic technology, we can accurately master the technical state of the equipment, track the progress process of the failure and calculate when the management values exceed the allowable limit. Consequently, we can accurately confirm when the annual overhaul starts. Thus the equipment maintenance will even more accord with the actual technology state, and the overmuch maintenance and the lack maintenance will be decreased or avoided. In this way, the failure rate and equipment maintenance costs will be greatly decreased.

- (4) Through accumulated necessary data and information by monitoring the equipment status, we can gradually perfect the Point Inspection standard of equipment.

Firstly, we must describe what is standard state? The descriptions take the vibration data as core are a system made up of various kinds of data. Therefore, the equipment of production line must be on-line real time monitor during the well running stage. And the enough data and relevant information will be accumulated, and then the equipment Point Inspection standard will be gradually perfect under the PDCA cycle method.

Chapter III Actuality Analysis on the Equipment Maintenance Management of BX STEEL

3.1 General Introduction of BX Steel

3.1.1 Situation Introduction of BX Steel

Benxin Iron & Steel (Group) Co.; Ltd. was found in 1905. From July 15th, 1949, BX Steel (for short) entirely recovered production. After new China established, we finished the recovery construction and addition revamp. Until 1952, annual pig iron output is 231,000 tons, and special steel output is 21,000 tons. During the first Five Years Plan, BX Steel was ranked as the key construction project. The first time addition and revamp after new country established started. From then on, the production capacity quickly expanded, pig iron output reached 804,000 tons, and special steel output reached 88,000 tons. During the 1960s, the production of BX Steel developed to a new level. In 1966, we finished the industrial total output value 390 million tons. The pig iron output reached 1.51 million tons, and the special output reached 145,000 tons. In the 1970s, we made a Three-Two-Two revamping solution (That means annual pig iron output is 3 million tons, carbon steel is 2 million tons, and

special steel is 200,000 tons.). So the second time large-scale revamp and expansion started. New iron ore, blast furnace, steel making plant and rolling mill were built, which formed the production capacity of the annual pig iron output 3 million tons, carbon steel 2 million tons and special steel 200,000 tons.

After reform and opening, BX Steel continuously coruscated out new vital force and energy. In Nov.1994, we were ranked as experimental enterprise for establishing modern enterprise system by State Department. In July 1996, we changed our system into Benxin Iron & Steel (Group) Co.; Ltd. authorized by State Department, we became a state-owned large iron and steel united enterprise. In Apr. 1997, we were identified as experimental enterprise of national 120 large enterprises by State Department. In Jun. 1997, we made up of BX STEEL Sheets Stock Co.; Ltd. by the Steel Making Plant, Hot Rolling Mill and Blooming Plant. Moreover, we successfully went into the stock market. We issued A stock 120 million, and B stock 400 million. From 1998 on, BX Steel started the fighting with three years revamps and hardness taking off. By pushing the Three-Revamping-One-Strengthen, we got some stage results.

After new century started, we took the reform as motive power, structure adjustment as masterstroke, insisted on system, management and technology innovation, and continuously quickened the revamping steps. Our company invested 10 billion RMB to revamp the ironmaking, steelmaking and rolling system. We had finished the revamp on the No.5 blast furnace, hot metal pretreatment and converter automation for steelmaking plant, 1700mm hot rolling mill train, 360m² cold ore sintering machine, color coated line, extraction Fe decrease Si for mine, the overhaul to No.4 blast furnace and No.5 coke oven, and the new construction to No.4 converter and refining device for steelmaking plant. The whole technical equipment levels have reached world advanced level and internal advanced level.

In 2007, annual steel output is 7.06 million tons, the year-on-year growth is 1.00%; hot rolling sheets are 6.72 tons, the year-on-year growth is 10.53%. The main business income is 31.352 billion RMB, which increase 17.00% than last year. The operating profit is 2.13 billion RMB, which increase 4.34% than last year. And the net profit is 1.699 billion RMB, which increase 4.49% than last year. BX Steel became an oversize iron and steel united enterprise owned mining, ore dressing, sintering, coking, iron making, steel making, steel rolling, power, transportation, science

research and developing, machine manufacture, real estate developing, construction, business and travel, as well as the national backbone enterprise for producing choice sheets.

3.1.2 Characteristics of the equipment of BX Steel

(1) Oversize equipment

The biggest characteristics for the equipment of metallurgical enterprise are the oversize equipment. BX Steel mainly include the following equipment: 4350m³ blast furnace, 360m² sintering machine, coke oven with 6m high carbonization room, 180t converter, 1700mm 7 housings hot rolling mill with annual output 4.3 million tons, and 5 housings cold rolling mill with annual output 1.9 million tons.

(2) Continuity of Production

The main production lines of BX Steel are tightly related each other. Any of the processes are failure that will affect the downstream production, even stop production. Even though the single process was separated into many steps, which any step is fault, the whole line will be stopped.

(3) Equipment Automation

During the production, computer control was widely adopted by BX Steel. So our production can be rhythmized, high quality, low consumption and high efficiency. For the electric automation, PLC was widely used instead of the control of relay and contactor. In addition, we equipped with many automation instruments, industrial TV and automatic electric weighing device.

(4) Equipment with high speed

The high speed production requires high speed running of equipment. For example, belt conveyor approximately runs under the speed of 50 km/h. And the maximum finishing speed for 4-high rolling mill with 7 housings is 18 m/s.

(5) Precise equipment

High quality products need precise equipment. For example: For the static unparallel of stand window less than 5 m should not be more than 0.03mm. At the same time, the forge mass of two vertical columns must be even. Thus under large rolling power, the deviation of dynamic deformation can be controlled in a small limitation. And then precise products can be guaranteed under 1000 m/min by the cold rolling mill. Furthermore, products tolerance is not more than 0.01 mm. Thus we can know the

equipment management is the important part for enterprise management of BX STEEL.

(6) Comprehensive technology

The technologies which include mechanical, electric, computer, hydraulic, vacuum, pneumatic all applied to the same equipment. So the equipment became more complex and advanced, which also provide more serious requirement for equipment maintenance and management.

3.2 Analysis on present equipment maintenance management mode of BX Steel

3.2.1 Point Inspection and Periodical Maintenance System

(1) Characteristics of Point Inspection & Periodical Maintenance System ^[6]

- Persisting in the guiding ideology of precaution : That means mainly precaution, and maximum decreases the accident and the failure.
- Establishing the complete maintenance standard system : The Point Inspection and Periodical Maintenance System include

maintenance technical standard, Point Inspection standard, grease feeding standard and maintenance standard, which are technical basis for executing the Point Inspection and Periodical Maintenance System.

- Establishing the management system taken the Point Inspection as core : The emphasis for BX Steel is the lower lever management. They can decrease the traditional unwanted steps, the information feedback is smoothly, and usage and management are related closely. So the high efficiency management can be reach.
- Clear management purpose : The failure time and maintenance costs of the equipment can be decreased, and then the maximum economic benefit can be reach.
- Sticking up the concept of service for production : Each maintenance project has its own standards, which include the working time and process table. So the production plan can be executed very well. And the requirement of maintenance project can be satisfied, that means they are homogenous between the production and the maintenance.
- Executing popular administration : The personnel that join the

production process must take care and attend the equipment maintenance. The operators and the maintenance personnel must work together, because they are the basis for executing popular administration.

- Adopting PDCA method : From the planning for Point Inspection and spare parts to executing the plan, and to the statistic and analysis for the various performances, we can find out the problems and make reform measures to construct the closed management mode PDCA.
- Insisting on safety first : Point Inspection& Periodical Maintenance System insist on the principle of safety first. It includes three measures: safety confirm, foreseen danger and safety consultation.
- Pushing forward the trend management of equipment: The equipment state and deterioration trend must be accurately and quantitatively mastered. Then the optimal solution can be made to prevent the overmuch maintenance and the lack maintenance.

(2) Necessary condition for pushing Point Inspection& Periodical Maintenance System

- The equipment must be accurately used and maintained ;

- The work division agreement among the Point Inspection, maintenance and operation must be clear ;
- The maintenance work must be executed efficiently ;
- The spare parts must be prepared under the requirement of Point Inspection ;
- Pushing forward the modernized lower management system around operator director system ;
- A technical group with rich experience and high techniques must be established.

(3) Equipment Point Inspection System

Equipment Point Inspection System take the Point Inspection as core, which is a comprehensive basic system to realized the reliability, maintainability, economy of equipment, and executed popular equipment administration^[7].

In order to maintain the original property of equipment, we use human five feelings (look, listen, smell, taste and touch) or the simple instrument to make foreseen setting inspection to some part (point) of equipment according to the foreseen setting cycle and methods, and then we must compare the site condition with the

presetting standard to confirm the equipment point work correct or not, thus we'll early find, prevent, and solve the potential failure and defects. So all above-mentioned is called Point Inspection.

In one word, the Point Inspection Management just uses the PDCA (Fig.3.1) working method to push the improvement of self quality and the accumulation of work experience. Consequently, the efficiency of Point Inspection will be increased continuously.

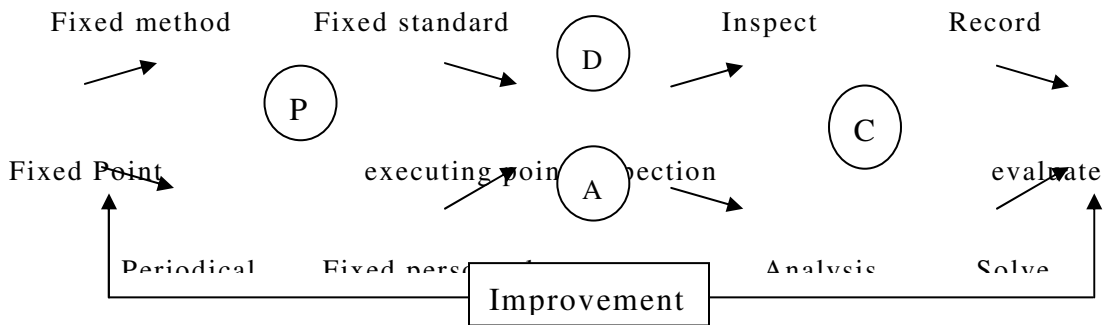


Fig.3.1 PDCA Working Method

(4) Periodical Maintenance of Equipment

Periodical Maintenance is a most efficient maintenance way, and also the optimal way for realizing foreseen maintenance of modernized equipment under the Foreseen Maintenance principle. After the point inspection personnel master the actual technical state and life cycle we can arrange short stop time for continuous production system, minimum lost for material flow and energy medium, and balance

control for maintenance load abided by the periodical maintenance cycle, time and load.

Under the guidance of periodical maintenance model, periodical maintenance system will follow the five steps: register → authorization → engineering acceptance → engineering execution → engineering record, which formed a set of scientific and tighten maintenance management system.

3.2.2 Equipment management mode taken point maintenance as core

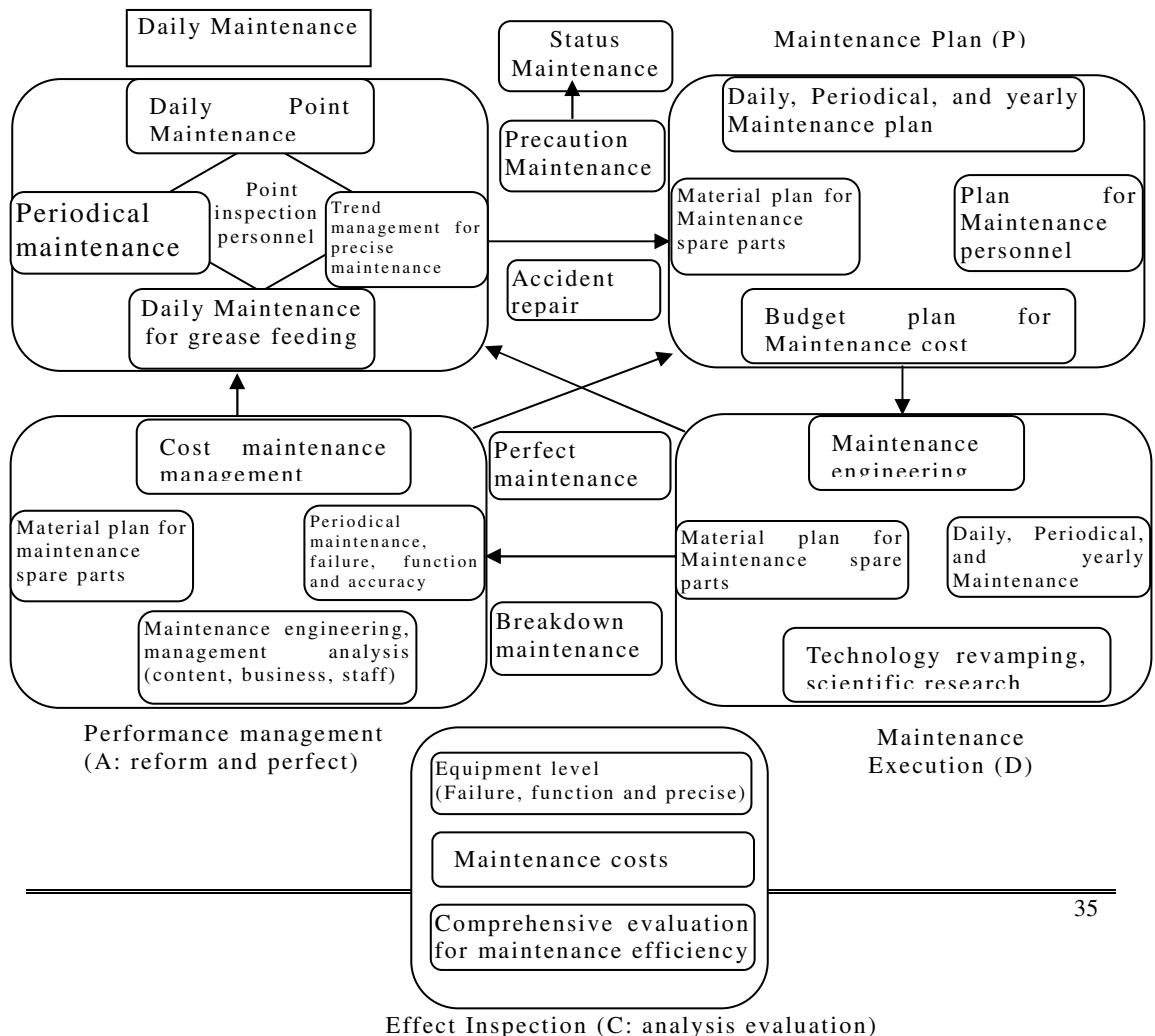


Fig. 3.2 Equipment management mode of BX Steel taken point inspection as core

The organized system for maintenance of BX Steel is made up of equipment department, equipment division of II class plant and the Maintenance Center. Equipment department is the managing division for all the equipment of BX Steel. They are responsible for pushing forward the point inspection and periodical maintenance, qualifying the qualification of maintenance personnel, and supervising the standard operating of the maintenance personnel. Equipment division, maintenance operation area and maintenance team for II class plant are the execution department for point inspection and periodical maintenance system. And Maintenance Center will also bear some point inspection job.

3.3 Put forwarding of Equipment Foreseen Maintenance of BX Steel

With the development of equipment diagnostic technology, the conversion of point inspection mode also was put forward. The present point inspection mode of BX Steel is Five Feelings point

inspection inspected by the experience and appearance of equipment running. This kind of method can't accurately and systematically describe the condition of equipment running, therefore which heavily block the cost decrease of maintenance, and affect the safe stable running of equipment. For example, the gear shafts of stand No.4 for BX POSCO Cold Rolling Mill was broken during running because of ignored the defects before broken. It directly delayed our production 18 hours. So it is necessary to put forward the status monitor and foreseen maintenance.

In the same industry, WISCO firstly push forward Any Point Controlled project to change the maintenance mode.

WISCO established the Any Point Controlled project for the important equipment from 2002. The strategy of the project is reliable equipment running and economical maintenance under the guidance of star class equipment management. The meaning includes: Firstly, it provide prepare condition for upgrading the technical methods of equipment management. Secondly, it pointed out the direction for executing maintenance strategy of *Combining Precaution and Foreseen* under the guidance of reliable theory. Thirdly, it provided the technical and manages support for realizing the aim of Double

Nine million tons. Until the end of 2004, WISCO reached actual annual iron output 8.8611 million tons, crude steel 9.0303 million tons, steel products 8.3518 million tons, and sales income 36.249 billion RMB. The productivity and profit index for iron and steel are all exceed the historical record. The equipment and management serviced for the economic growth also exert the best efficiency. The technical and economical indexes for the main equipment all reach the best historical level, in which the average availability is 87.03%, and accident and failure rate are 2.66%. Compared with 2002, the availability increased 8.8%, and accident and failure rate decreased 13.92%. With increases of all the index level, it provided powerful support and guarantee for realizing the production and business aim.

Any Point Controlled theory is based on the reliability theory(RCM). According to the process state data of equipment, we'll realize the Foreseen Maintenance and status controlled aim by monitoring, analyzing and managing the process of important running state data of vibration, shift, noise, temperature, pressure, flow, etc., and mastering the equipment running state and deterioration trend. Above-mentioned is one of the research objects for reliability theory.

BX Steel is as same as WISCO belonged to the oversize iron and steel

enterprise. The success of WISCO proved it is possible to execute state monitor and Foreseen Maintenance.

Chapter 4 Design and Execution for Foreseen Maintenance Solution of BX STEEL

Execution of Foreseen Maintenance is the basis of equipment status monitor. The characteristics of status monitor are more input, high risk, quick developed technology and high quality requirement for operators. According the actual business condition and personnel quality of BX Steel, we adopted multiple step method. At first, we took the 1880mm production line of hot rolling mill as experimental plant, planed to invest 1.6 million RMB to finish the job. The following discusses to Foreseen Maintenance solution are made combined with our 1880mm production line of hot rolling mill.

4.1 Design for Foreseen Maintenance Solution of BX Steel

4.1.1 General structure and form of solution

(1) Combination of on-line monitors and off-line detect

To the sticking points of key equipment (roughing mill, finishing mill and coiler) and inconvenient points of 1880mm production line adopted on-line monitor and diagnostic (some part can consider to

use wireless transmit solution of data). The on-line monitor system will not only synchronously monitor the vibration, but also monitor the revolution, temperature, shaft shift, motor current, torque and all process signals of equipment. And then equipment state will be promptly and accurately controlled, they can eliminate the sudden accident of key equipment.

For other equipment, we can use comprehensive point inspector, precise point inspector and vibration signal analyzer to make off-line detection. And then state controlled, deterioration trend predict and precise diagnostic of all the equipment will be realized. Off-line detection can realize the state controlled of all equipment by optimal cost, which is also the possible compensation way for on-line monitor system. They not only can verify the data of on-line inspecting points, but also can find out the abnormality of equipment from on-line monitor system, then to compensate the relevant data. On-line monitor and off-line detection are all supported by equipment state management system, they use the same database. For one equipment, the data from on -line monitor and off-line detection can be compatible and compensable each other.

(2) General structure chart of status monitor solution

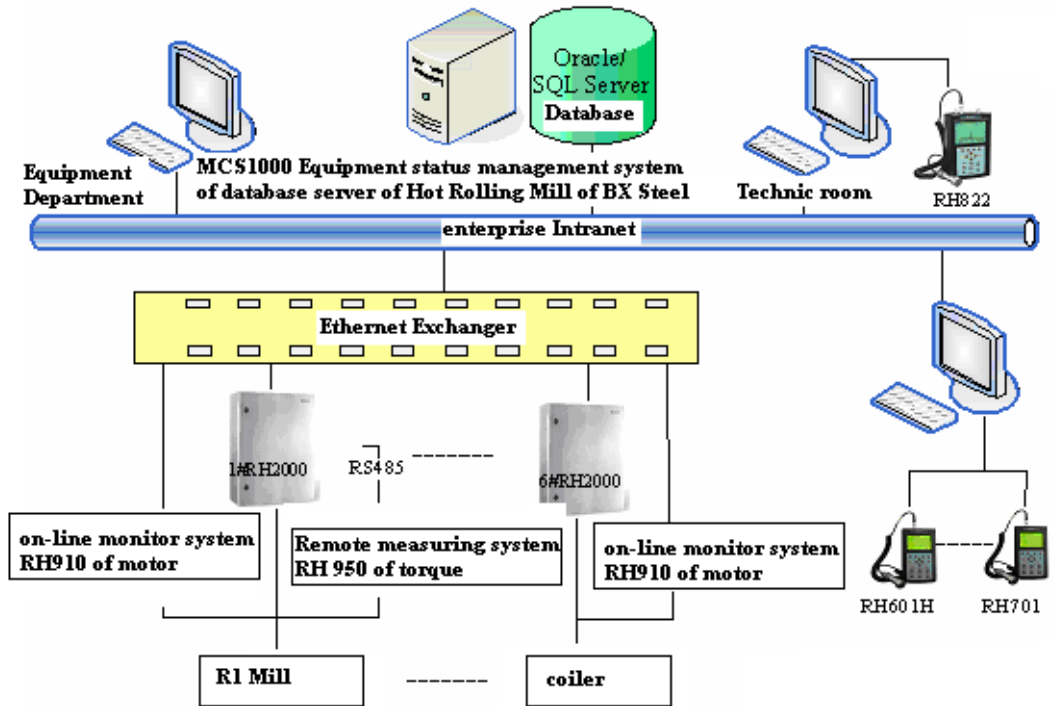


Fig. 4.1 General Structure

(3) Constitutes of status monitor solution

The status monitor solution of 1880mm production line of hot rolling mill is made up of equipment status management system, comprehensive on-line monitor and analysis system, motor on-line monitor system, torque on-line remote measure system, comprehensive point inspector, precise point inspector, vibration signal analyzer, acceleration transducer, vortex sensor, temperature sensor, armored cable and electronic button. Comprehensive on-line monitor system, motor on-line monitor system and torque on-line

remote measure system can realize the comprehensive on-line monitor of the key equipment. And the other equipment will adopt comprehensive point inspector, precise point inspector to make periodical point inspection and detect. And the vibration signal analyzer is used to precise diagnostics of equipment and data verification for on-line monitor points.

4.1.2 Comprehensive on-line monitor solution of key equipment

(1) Combination of on-line monitors and off-line detect

To the sticking points of key equipment (roughing mill, finishing mill and coiler) and inconvenient points of 1880mm production line adopted on-line monitor and diagnostic (some part can consider to use wireless transmit solution of data). The on-line monitor system will not only synchronously monitor the vibration, but also monitor the revolution, temperature, shaft shift, motor current, torque and all process signals of equipment. And then equipment state will be promptly and accurately controlled, they can eliminate the sudden accident of key equipment.

For other equipment, we can use comprehensive point inspector, precise point inspector and vibration signal analyzer to make

off-line detection. And then state controlled, deterioration trend predict and precise diagnostic of all the equipment will be realized. Off-line detection can realize the state controlled of all equipment by optimal cost, which is also the possible compensation way for on-line monitor system. They not only can verify the data of on-line inspecting points, but also can find out the abnormality of equipment from on-line monitor system, then to compensate the relevant data. On-line monitor and off-line detection are all supported by equipment state management system, they use the same database. For one equipment, the data from on -line monitor and off-line detection can be compatible and compensable each other.

4.1.3 Function characteristics of system

(1) The system will provide many tables included equipment technical documents, equipment state, state analysis, point inspection management. The management personnel and special analyzers can timely know and analyze the equipment status, and uniformly to control the point inspection by monitor solution.

For example:



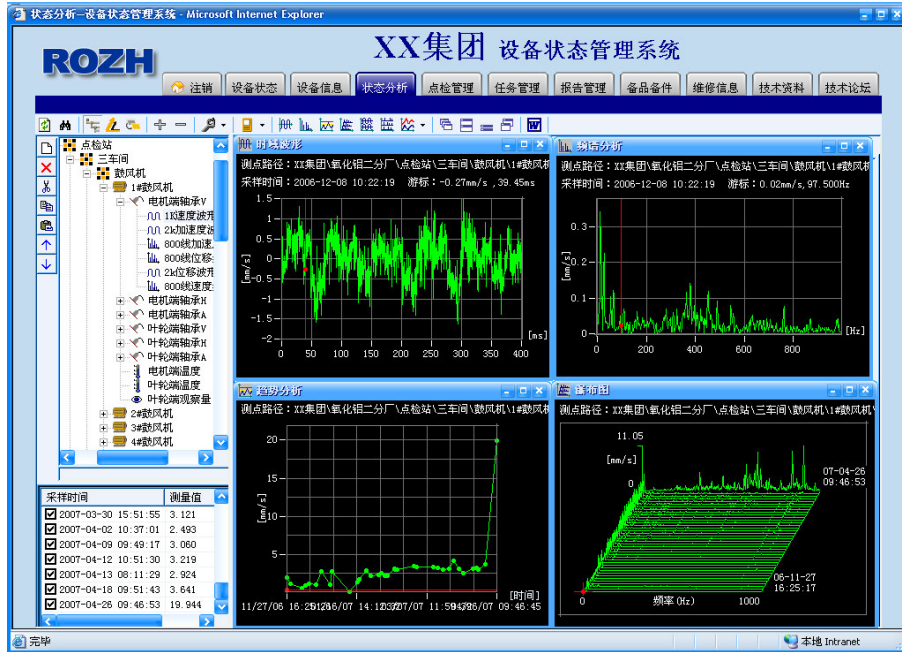
(2) Real time indication and analysis for equipment state

The system provided many analysis tools to support the real time indication and analysis for on-line and off-line data acquisition, which include time domain waveform, trend graph, frequency spectrum, locus of journal center, waterfall graph, envelope demodulation, etc. The system bearing database supports the automatic verification and label of all acquisition data.

The system can automatically verify the equipment status, make relevant automatic alarm and support the location for alarm point and reasons according to preset. The presetting means statistic alarm setting for time domain and frequency domain index of vibration, and other process data (revolution, temperature and current, etc.).

So the status identification is realized on the basis of the enough and complete equipment status information.

For example:



(3) Realizing remote diagnostic

The data of on-line monitor and off-line detect are not limited to only one computer, which can be real time indicated and analyzed on any one network computer and realize the remote diagnostic of equipment. They'll greatly improve the monitor and diagnostic efficiency of comprehensive monitor system and make the persons with ability to grow up and training more easily.

(4) Automatic generation function of report

It can generate all the interface, character frequency list, equipment total value list, major peak value list into Word document, which is very convenient to write analysis report and provide the detail data support for equipment maintenance.

(5) Open data platform, seamless connection with ERP system

Equipment status management system on Network provided standard data interface for various equipment information system, which can interface with other equipment data, and also can share the data with ERP system. It provides the data support for the branch system of equipment management in ERP system. Consequently, the maintenance plan can be made and spare parts can be managed more scientifically.

(6) Periodical maintenance module and yearly maintenance plan for automatic generation equipment

The system will make trend analysis according to the data from on-line and off-line inspection, by which the system can generate equipment periodical module, relevant yearly maintenance plan, and spare parts storage and consumption plan to realize the closed-loop control for point inspection management.

The automatic generated equipment periodical module, relevant

yearly maintenance plan, and spare parts storage and consumption plan all can be manually adjusted.

(7) Failure statistic and analysis function

By the traditional failure statistic data, off-line detection and on-line monitor results, the system will provide the function of failure analysis graph, failure trend and maintenance recommendation.

4.2 Execution on Equipment Foreseen Maintenance Solution of BX Steel

(1) Analysis the demand, perfecting the solution

To choose the type and quantity for equipment status management system, comprehensive on-line monitor and analysis system, and off-line inspection device (comprehensive point inspector, precise point inspector and vibration signal analyzer);

(2) Personnel training

By operation training to the on-line system and off-line inspection device, the relevant technical personnel and point inspection personnel will master the operation and use methods for on-line system, comprehensive point inspector, precise inspector and vibration signal analyzer.

The training include to finish the choice of monitor point, set acquisition data, entry the basic equipment information, correctly use for comprehensive point inspector, precise inspector and vibration signal analyzer. The flow chart is specified in fig.4.2.

- (3) Establishment of relevant management system for status monitor equipment

For the application of new equipment and new technology, the relevant system and rules should be established to guarantee the efficient use of equipment. And new system and rules should be combined with the original one to perfect the whole system and rules.

- (4) To establish the strict check system for equipment management, rewards and punishment must put into effect

For the new equipment, the rewards and punishment system must be established immediately. Clear task and clear responsibility will be explicitly listed in the monthly check table about the equipment information for basic management, status monitor and maintenance. The monthly reports can be the evidence for year end rewards, promotion and next year appoints

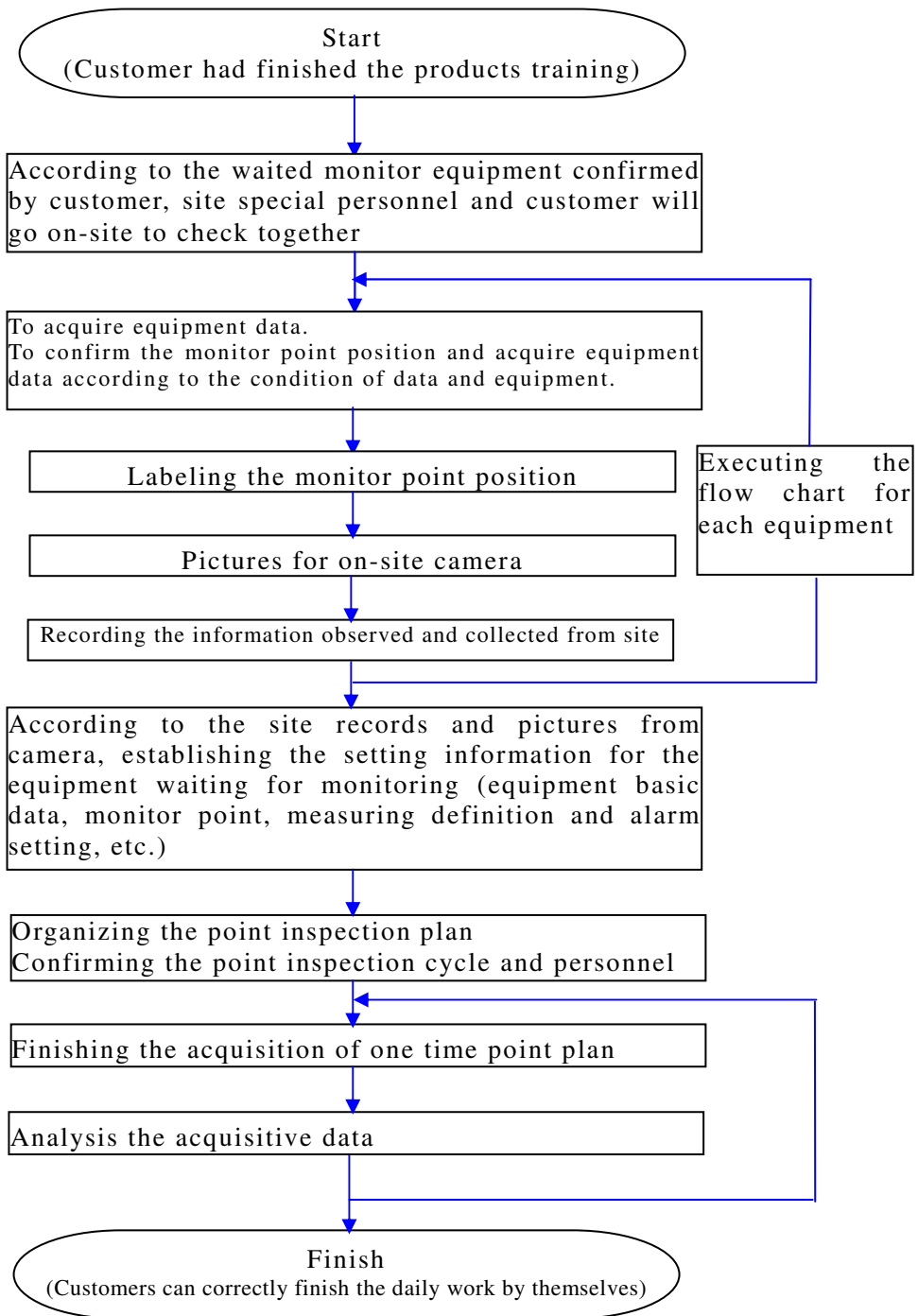


Fig. 4 Training flow chart

Chapter V Conclusion and Prospect

This article makes research on the execution of Foreseen Maintenance and push measures of BX Steel, puts forward the detail improved solution and gets the relevant study results on the basis of analysis to the equipment management and Foreseen Maintenance theory, and WISCO Any Point Controlled project.

5.1 Research Conclusion

According to the sum up of the research of this article, the conclusion is as follows:

(1) It is very important to push forward the Foreseen Maintenance.

Firstly, reform to equipment maintenance system requires execution of equipment status monitor and Foreseen Maintenance. At same time, the sudden failure and maintenance costs can be efficiently decreased. The possible data and information are accumulated through equipment status monitor to perfect the point inspection standard of equipment.

(2) It is feasible to push Foreseen Maintenance.

By description to the function of WISCO Any Point Controlled,

this article argued it is feasible to BX Steel to execute the equipment status monitor and Foreseen Maintenance same as WISCO.

- (3) Foreseen Maintenance is the certain trend to the innovation and development of maintenance system of BX Steel.

With development of science and technology and appearance of advanced inspection equipment, it certainly results in the innovation and development of Point Inspection and maintenance system.

- (4) Put forward the solution for executing Foreseen Maintenance

By research on the equipment maintenance theory and the actual conditions of BX Steel, the detail innovated solution was put forward.

5.2 Further research

According to the innovation of quick developed condition and equipment maintenance theory of BX Steel, the article makes more perfection and research on the followings:

- (1) How to integrate the multi-maintenance strategy under many kinds of maintenance methods. Foreseen Maintenance is based on the status monitor, the cost is very high. So the maintenance strategy

must be integrated.

- (2) TnPM means total normative production maintenance. It is the certain trend to the development of equipment management. So we should combine the actual condition of BX Steel with TnPM together.
- (3) With the on-line running of ERP system, the next step to be research is how to combine the status monitor, Foreseen Maintenance and ERP system together.

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