

# Design & Implementation about Mining Enterprise EAM (Enterprise Asset Management) System

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## Abstract:

EAM (Enterprise Asset Management) is a generic term of enterprise information solution which is for asset concentrated enterprise. The goal is to raise asset utilizing ratio and low down enterprise performance & maintenance cost. Optimizing enterprise maintenance resources is the core, thus reasonably arrange maintenance plans and related resources and behaviors via information means. To raise equipment utilizing ratio thus increases benefits; low down the cost by optimizing maintenance resources. By these means it can raise enterprise's economic benefits and the market competitive ability. EAM's concept is to make traditional passive maintenance changed to positive prevention maintenance. By integrated with real-time data gathering system, thus to implement prevention maintenance. By tracking and recording enterprise's maintenance history behaviors, thus maintenance personnel's personal knowledge shall transform to enterprise's intelligence assets.

The mining industry company is most important raw materials base of Anshan Iron and Steel Group Corporation, the enterprise's size is the fourth in the world. Among recent years, the mining industry company catches the advantage chance when iron ore price has significantly increased then the company has concentrated funds to conduct mass technical reformation. While production technology reformation is complete, main equipments have reliably performing automated control; we have conduct investigation and analysis, together with knowledge of production management, equipment management, energy management, maintenance management, etc. Integrated with database technology, work stream technology and .NET technology, we have implemented the EAM (Enterprise Asset Management) information system, which the core is "inspection at point and periodical maintenance", the main thread is "inspection and maintenance cooperation", and it covers part of the production information. This system integrates production management information together with equipment performance information, thus enables data accuracy, availability and utility.

**Keywords:** Enterprise Asset Management; Design; implementation

## 1 The purpose to implement EAM system

There were several problems existed among previous equipment management works in the mining company:

Equipment performance status can not be known by each level's management personnel, especially for the imported latest equipments. Equipment's inspection point and maintenance rule are not known, as well the spare parts quality varies, which lead to equipment maintenance delay thus causes accident or over-maintained thus makes spare parts waste, increase the cost.

Plant equipment management was type of manual recording and paper based, manually analyzing. Because of mass data gathering and analyzing, which causes waste of time and strength, leads to ineffective working. Data lost and personnel effect is mass, different management personnel shall make different effects, thus makes difficulties on Level 3 inspection and checking.

Production management is apart from equipment management. Traditionally production management and equipment management are in different management pattern, which restrict advancing development of production.

Inaccurate spare parts information, thus makes useless overstock, and lack of useful parts, thus brings difficulties on maintenance. Equipment system has higher fault ratio and lower performance, thus cause low production.

To change the situation, it is urgent to establish a complete new equipment management system. The new system can promote equipment management upgrading, make TPM management work to develop deeply, thus the asset utilizing can be optimized, investment repayment can be maximized, then we shall make a digital mine.

After learning, we have known than EAM is an application software which takes enterprise asset and maintenance management as the essential. It includes: fundamental management, working sheet management, prevention maintenance management, asset management, performance project management, safety management, stock management, purchase management, reporting form management, maintenance management, data gathering

management, work stream management, determination analyzing management, etc.

After the technical reformation, we have made a high level equipment situation, main equipments have been made automated control, with continuous training, the company staff has improved their personal qualities. All these are making foundations for EAM system. We are trying to be with EAM system, thus implement the full process management of equipments, make specialist technician cooperate, to know the complicated equipment system, bring management level to high level, thus ensure production performs in safety conditions. By enhance daily maintenance, handle fault timely, improve equipment reliability, thus to make equipments performing safely, reliably and steadily. As well, under precondition than equipments are in good status, we shall reduce the maintenance time period, low down the cost, carry out maintenance in advance, raise equipment's availability, enhance maintenance personnel examination, thus to increase economic benefits.

## **2 Deign and implementation about Mining Enterprise EAM (Enterprise Asset Management) System**

### **2.1 Introduction of EAM system**

This system has dynamic equipment knowledge library which is made by "Equipment Fundamental Data System" which complies to international standards. The system use unified standing by mechanism.

Mining industry equipment management system is closed loop system, from the view point of maintenance, the system has 3 levels: maintenance plan, maintenance treatment and afterwards analyzing. Maintenance plan is to work out maintenance standards and plans according to equipment fundamental data and maintenance history. Maintenance treatment is to execute the plan and gather maintenance history data. Afterwards analyzing is to analyze maintenance data, make the result feedback to maintenance plan. By revising maintenance plan standards, thus make it more accurate and feasible, reduce non-plan maintenance and rush maintenance, then reduce maintenance cost. EAM has 3 types of data: static data (includes equipment and spare parts category information, property information, technical instruction, specific amount index, location information, supplier information, tools information, maintenance information, etc.); dynamic data (equipment performance data, maintenance data, removable data, spare parts stock data, purchase contract data, maintenance working sheet data, etc.); intermediate data (various enquiry results, statistic report forms, analyzing results, etc.).

### **2.2 Design principle of EAM system**

We follow these principles when designing EAM system.

(1) Unify and multiple step principle. For maintain EAM system property, on the basis of unifying plan, then executing in multiple steps, thus to reduce system risk, make sure the system is implemented successfully.

(2) Economic and practical principle. Make sure the system has friendly and unified user interface, easy to operate, use and maintain. It can deal with practical problems, use mature technology. System's performance reaches requirements, on this basis, we try to make less investment.

(3) Flexible and high efficiency principle. Make sure the system has good performance, high processing efficiency, easy and flexible to configure and use, has high processing speed.

(4) Safety and reliability principle. To establish complete and entire network resources saving and loading control system. Strictly identify network user's authorities, thus to avoid data information access without permission. Use high reliable and steady enterprise level network operating system, database system and related hardware platform. To apply measures on both software and hardware, then to make sure information storage and access reliability.

(5) Mature and advanced principle. The system must use advanced and mature computer software and hardware technology, to make the system in high technical level, as well to make sure the system is safe and reliable.

(6) Inheritance and economy principle. The system shall protect existing information system investment, to protect existing applicable subsystem investment. Efficiently use information resources which are gathered by current application system and production control system. Use data interface program to transfer data to the EAM system, thus to implement information sharing with existing system.

(7) Extension and open principle. EAM system is to be improved; this requires good ability of extension. The system must use standard and open technology, thus make the system has good extension ability and adjust to technology development and user's requirements. Technical documentation must be entire and complete, for easy maintenance.

### **2.3 EAM System Structure**

EAM system software overall structure is shown as below Figure 1.

The entire system body is B / S structure, user interface is WEB style, all page design is based on 800×600 resolution. System software page design structure graph is shown as below Figure 2.

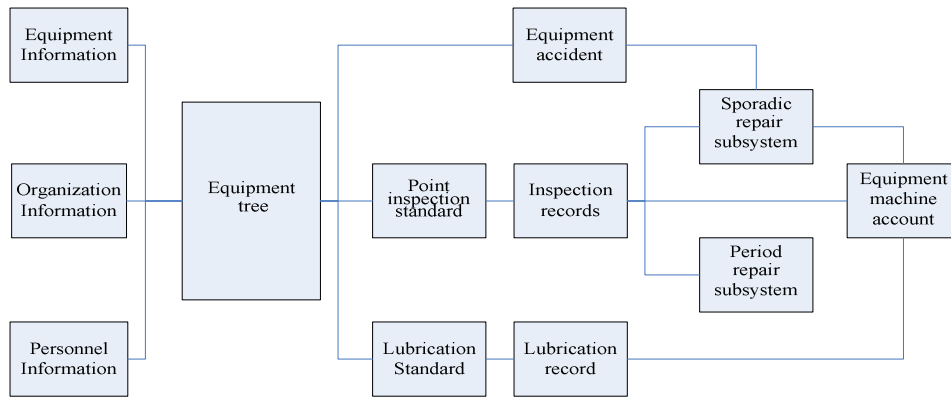


Figure 1 System software overall structure graph



Figure 2 System software page design structure graph

EAM system and other systems have left interfaces. The interface for production system is for receiving main equipment output data; interface for real time database is for analyzing performance status of equipment.

EAM system uses equipment tree structure. After establishing the database, it will link all system and equipment together as a tree, thus make the equipment system. As well integrating static

equipment basic information data, four standards, point inspection information, hazard source, frequently used spare parts, spare parts replacement location and replacement records to be one entity, thus make data integration for point inspection, maintenance, fault accident and equipment life monitoring, spare parts replacement monitoring, lubrication monitoring, etc. The work connects to each other, makes integration of equipment system,

thus carrying out equipment service life management, spare parts life period management.

## 2.4 EAM system module function analysis

### 2.4.1 System configuration subsystem

(1) Data dictionary

① Personnel information dictionary

Include personnel post, professional title and other basic information configuration.

② Equipment type

A Essential equipment, B Important equipment, C General equipment

③ Material type

Spare parts encoding dictionary / material encoding dictionary

Spare parts shall be in category, such as mechanical, electrical, imported, domestic, etc.

④ Professional dictionary

Measuring unit

⑤ Accident category

Extraordinary serious accident, serious accident, large accident, and general accident.

⑥ Equipment status dictionary

Sealed and stopped, waiting for rejection, in use, spare

⑦ Equipment specialist dictionary

Equipment category includes mechanical equipment, electrical equipment, power equipment, etc.

(2) Organization

① Personnel / Station / Organization

② Personnel management range (equipment) configuration

According to different personnel management range, system administrator can make configuration according to personnel's actual equipment administrative authority.

### 2.4.2 Equipment basic information subsystem

The equipment basic information subsystem includes: equipment basic information, equipment main technical parameter, equipment diagram, frequently used spare parts list, motor's main technical parameter, decelerator's main technical

parameter, equipment parts list.

### 2.4.3 Point inspection management subsystem

(1) Point inspection standard

Point inspection standard workout

Includes station, profession, precise point inspection standard

(2) Point inspection standard fault

① Station point inspection achievement making

The station inspector uses station point inspection card period standard to conduct point inspection achievement recording and fault recording.

② Professional point inspection achievement making

Professional uses station point inspection card period standard to conduct point inspection achievement recording and fault recording.

### 2.4.4 Fault treatment subsystem

(1) Fault treatment

During the fault treatment the fault can be treated, with following methods

Issue inspection operation sheet

Select fault then issue inspection operation sheet, thus entrust cooperation unit conduct repairing and maintenance.

Handing down faults.

Treat to be handing down fault and stand by for maintenance.

Treat to normal status.

Some faults in different time or space may not be faults, with treatment; the faults can be treated to normal.

Turned to be periodical maintenance

During maintenance some faults may affect many aspects; these faults can be treated by next periodical maintenance.

Faults revision.

Some found faults may have recording error, shall be treated by fault revision.

Fault delete.

By this mean, redundant faults can be deleted.

(2) Fault tracking

After fault treatment can conduct tracking on fault status. Use different colors in the display record, thus to indicate different treatment status of faults.

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部门名称	设备名称	点检项目	点检内容	缺陷现象	点检人	点检员意见	缺陷日期	缺陷来源	当前状态	是否处理
铁路运输	QKCTY-EL2电机车	车体照明	车体照明	台车灯、线路灯、	于洋		2006-10-12 14	岗检	已下票	☑
穿爆车间	QKCCB-Y255牙轮行走机构	轨板松紧是否适度	1、更换左侧张紧轮	马世刚	更换, 焊接	2006-10-12 14	专检(机械)	已下票	☑	
穿爆车间	QKCCB-Y255牙轮机架与机体	联接螺栓是否齐全	1、处理左侧前顶子	马世刚	更换, 焊接	2006-10-12 14	专检(机械)	已下票	☑	
穿爆车间	QKCCB-45R牙轮钻架	上部钻杆装置	1、恢复左侧钻杆架	马世刚	更换, 焊接	2006-10-12 14	岗检	已下票	☑	
穿爆车间	QKCCB-45R牙轮平台	围栏、观察空	1、小平台观察孔盖	马世刚	焊接, 更换	2006-10-12 14	岗检	已下票	☑	
穿爆车间	QKCCB-45R牙轮主机机构	运行是否平稳	1、主机机构加压离合	马世刚	更换, 焊接	2006-10-12 14	专检(机械)	已下票	☑	
穿爆车间	QKCCB-45R牙轮行走机构	履带是否开焊断裂	1、左侧光轮油管断	马世刚	更换, 焊接	2006-10-12 14	专检(机械)	已下票	☑	
炸药车间	QKCZY-乳化炸药软管卷筒	接头、支架、轴承	卷筒牙盘调整	洪艳伟		2006-10-12 14	故障	已下票	☑	
采矿车间	QKCCK-4立电铲-1综合部分	各部抱闸	二车,右回转向瓦各	赵洪喜	更换	2006-10-12 14	专检(机械)	已接收	☑	
采矿车间	QKCCK-4立电铲-1综合部分	主体螺栓	螺栓螺丝弯一根	徐庆涛	更换	2006-10-12 14	专检(机械)	已接收	☑	
采矿车间	QKCCK-4立电铲-1铲具部分和大架子	铲斗、铲杆、联接器	斗尾下保护板开焊	徐庆涛	补焊	2006-10-12 14	岗检	已接收	☑	
采矿车间	QKCCK-4立电铲-1综合部分	各部制动	右侧回转向瓦各	徐庆涛	更换	2006-10-12 14	岗检	已接收	☑	
炸药车间	QKCCY-粒输间	三角皮带	松紧及磨损情况	破碎机电带罩开焊	洪艳伟		2006-10-12 14	岗检	已下票	☑
炸药车间	QKCZY-乳化炸药软管卷筒	接头、支架、轴承	卷筒滑轮劣化	洪艳伟		2006-10-12 14	故障	已下票	☑	
炸药车间	QKCCY-乳化炸药六大安全装置	刹车、转向、灯光	后刹车灯不亮	洪艳伟		2006-10-12 14	故障	已下票	☑	
炸药车间	QKCCY-乳化炸药六大安全装置	刹车、转向、灯光	手刹车不好使	洪艳伟		2006-10-12 14	故障	已下票	☑	

数量:17

Figure 3 Fault tracking diagram

**2.4.5. Inspection management subsystem**

(1) Workout each inspection standard

① Inspection and maintenance technology standard

② Inspection and maintenance operation standard

(2) Zero maintenance management modules (production realistic system).

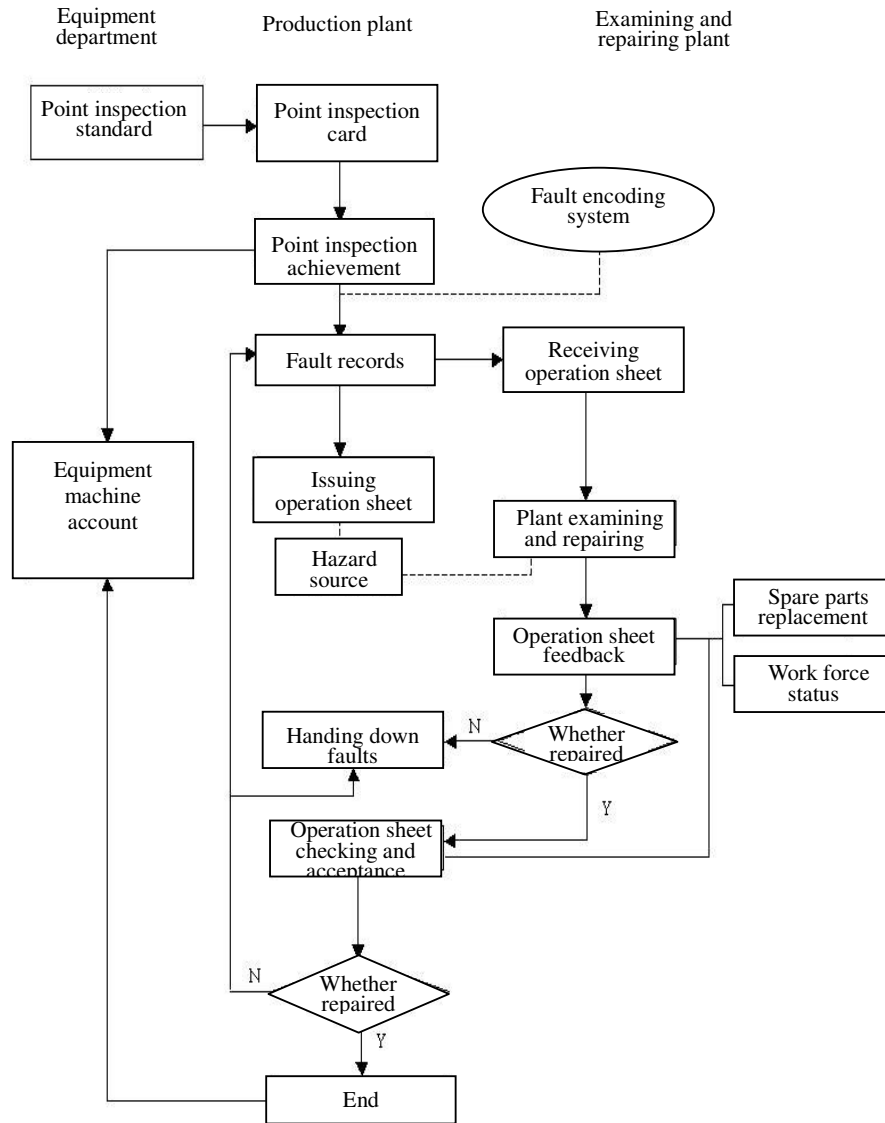


Figure 4 Zero maintenance flow chart

① Receiving operation sheet

After the production plant has issued operation sheet, on cooperation plant's log on page all operation sheet shall be displayed to be received.

② Operation sheet feedback

After maintenance item is repaired, cooperation plant shall fill maintenance process and spare parts replacement, then makes feed back to production plant.

③ Operation sheet checking and acceptance

The production plant shall confirm every feed back operation sheet. Unqualified operation sheet

may not be confirmed. Unqualified operation sheet shall lead to a fault information, stand by for next treatment in production plant.

④ Operation sheet tracking

On the operation sheet page user can track sheet status. The record shows different colors, display 4 treatment statuses (issuing operation sheet, receiving operation sheet, operation sheet feed back, operation sheet checking and acceptance finished).

(3) Periodical maintenance management module (equipment management system).

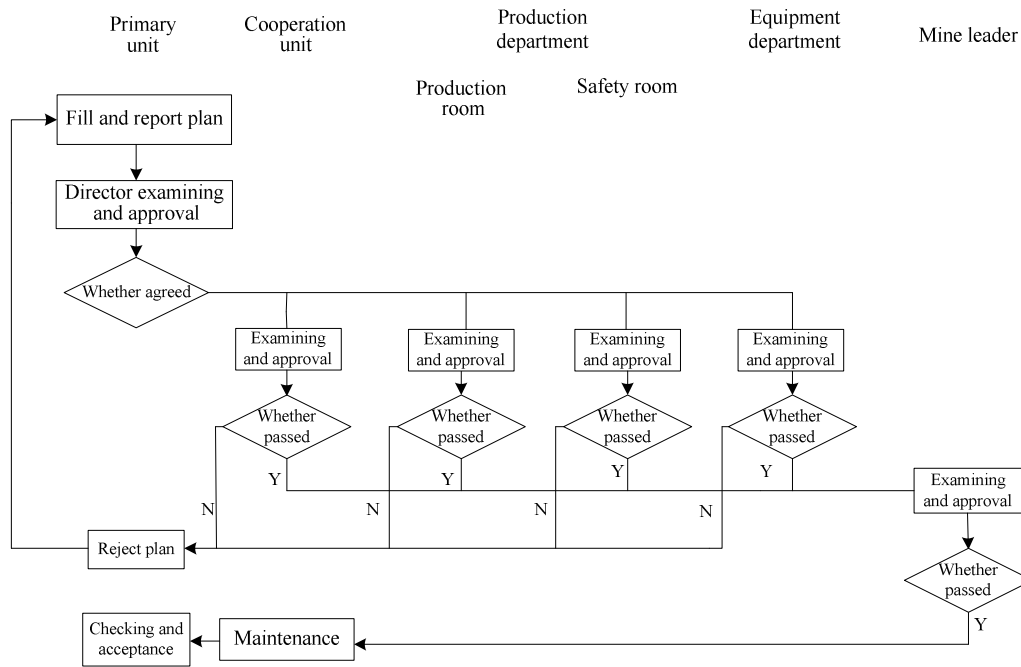


Figure 5 Periodical maintenance flow chart

- ① Periodical maintenance standard workout
- ② Plant periodical maintenance plan workout  
The plant technician shall work out next week's maintenance plan on every Friday.
- ③ Plant periodical maintenance plan examining and approval  
According to enterprise's situation, the examining and approval process can be different.
- ④ Periodical maintenance execution, checking and acceptance  
The plant technician is in charge for tracking periodical maintenance execution, checking and acceptance, thus makes the operation sheet time and checking and acceptance for repairing item.

#### 2.4.6 Equipment lubrication subsystem

The lubrication status period chart has shown each equipment lubrication point period, number and lubricant types. The lubrication status detailed chart shows previous lubricating time, next lubricating time and remaining time before next lubricating time. These items are generated automatically by computer; it shall notice equipment personnel to work out periodical maintenance plan.

- (1) Equipment lubrication standard work out.
- (2) Equipment lubrication data management.
- (3) Equipment lubrication information prompt.

### 3 The effects of implementing EAM system

Sine the mining industry enterprise EAM (equipment asset management) has put into performance, with continuous improvement; it has become the absolutely necessary part in production management. During daily work, station personnel find problems by circuit inspection, then report to plant dispatcher

via EAM system. The dispatcher makes decision about issuing operation sheet according to the fault degrees. Once operation sheet is issued, the maintenance plant shall receive immediately. After signing in, the plant shall dispatch maintenance personnel to treat the fault, as well notice production plant about personnel dispatching situation. After maintenance, notice production plant to check and approve. After checking and approval the production plant shall record situation via EAM system. Until now the fault is perfectly treated, otherwise the system shall prompt that fault is not treated. During the process of the work flow, the EAM system automatically record equipment fault status, maintenance operation sheet and personnel's organization and working hours, thus make foundations for further detailed management.

Management staff can master equipment maintenance status via the EAM system, thus conduct emphasizing supervising.

Now the mining industry company has used EAM system to manage equipment periodical maintenance and production maintenance. The out-of-date manual planning and rushing reporting ways are completely abandoned. To use this system, working efficiency has raised a lot, equipment management work is more reasonable and comply to science.

From one year practice, we used information technology to reform traditional industry and execute EAM system project, thus improve equipment management work, maintain enterprise's normal production order, raise production efficiency and enhance enterprise energy. On the basis of keeping maintenance quality, by scientifically working out maintenance period, raised equipment starting ratio, thus low down maintenance cost.

To implement EAM system has brought deep impression to the company's personnel about the power of modern science and technology.

#### **4 Further work scheme of implementing EAM (enterprise asset management) system**

All information system should be continuously improved. Among further work, we have such consideration about the EAM system.

##### **4.1 To improve the equipment performance subsystem**

Use the interface between EAM system and real time database, to implement automatic performance data update. This shall make automatically generation of equipment performance status, fault management, accident management and such data.

##### **4.2 Establish prevention maintenance subsystem**

Increase online intelligent inspection means and equipment performance analyzing functions; in order to control equipment performance status at real time. Turn traditional passive maintenance to positive prevention maintenance.

##### **4.3 Material spare parts management subsystem**

Use interface between EAM system and spare parts library management system, thus to implement information synchronization of spare parts stock and consumption information. The system has intelligence management functions such as alarming.

##### **4.4 Integrated analyzing subsystem**

Improve EAM system integrated analyzing functions, implement functions such as equipment performance index analyzing, equipment deterioration analyzing, equipment fault reason analyzing, frequently used spare parts service period analyzing, etc.

Nowadays commercial competing becomes more serious, to those enterprises which have high value assets, equipment maintenance is no longer limited to cost, however it becomes strategic tool to gain profit. We shall continue to make effort, make the EAM system more mature and handle with real problems among production and equipment management. It shall make greater contribution for enterprise management upgrading and technology advancing.