

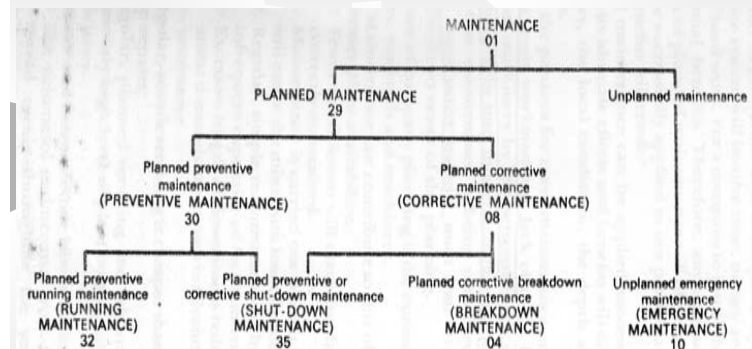
ESTABLISHING A PLANNED MAINTENANCE SYSTEM

Assoc Prof Zainal Abidin Ahmad
Universiti Teknologi Malaysia
2007

- Planned maintenance - definition
- ITEM 1: Initiating the Scheme
- ITEM 2 : The Inventory
- ITEM 3 : Identification of Plant & Equipment
- ITEM 4 : The Facility Register
- ITEM 5 : Maintenance Schedule
- ITEM 6 : Job Specification
- ITEM 7 : The Maintenance Program
- ITEM 8 : The Control Cycle
- ITEM 9 : Job Report
- ITEM 10 : The History Record

• Planned Maintenance

- Not a specific type of maintenance
- The application of maintenance tackled in a scientific manner
- The comprehensive planning of the maintenance function
- By definition – work organized and carried out with forethought, control and records
- Include the whole range of maintenance & can apply equally to any type – replacement, breakdown or preventive, provided that
 - The maintenance policy has been considered carefully
 - The application of the policy is planned in advanced
 - The work is controlled and directed to conform to the prearranged plan
 - Historical and statistical records are compiled and maintained to assess the results and to provide guide to future policy.



☀ **Planned Maintenance – deciding in advance**

- The individual items of plant and equipment to be maintained
- The form, method and details of how each item is to be maintained
- The tools, replacement, spare, tradesmen & time that will be required
- The frequency of maintenance
- Method of administering & analyse the result

☀ **Planned Maintenance – there must be;**

- A schedule of **all** the plant and equipment to be maintained
- A complete schedule of **all the individual tasks** that must be carried out
- A program of events indicating **when** each task must be carried out
- A method of **ensuring** that the work listed in the program is carried out
- A method of **recording** the results and **assessing** the effectiveness of the program

☀ **Planned Maintenance – Contribute to the company's objective of optimization of its resources – men, money, material & machinery as follows;**

- Greater plant availability
 - Fewer breakdowns
 - Maintenance is carried out in the most convenient and minimum loss to production
 - Regular, simple maintenance results in less downtime than infrequent expensive ad hoc maintenance
 - Reducing excessive downtime by knowing in advance the spares and equipment

- Regular, simple servicing is cheaper than sudden expensive stop gap repairs.
- Regular, simple servicing and adjustment maintains a continuously high level of plant output, quality, performance and efficiency
- Greater and more effective labour utilization
 - Planned maintenance work volume
 - Weekly workload known in advanced
 - Improve personal attitude of staff. A purposeful approach – higher morale
- Avoid overlooking or omission
- Improved budgetary control, stock control of spares
- Provide realistic forecast & decisions

- **What** is to be maintained?
 - **How** is it to be maintained?
 - **When** is it to be maintained?
 - Is the maintenance **effective**?
- Large or small, simple or sophisticated system, the basic elements are common to all, though the manner in which they are used differ in each case, depending upon the individual circumstances.

ITEM 1: Initiating the Scheme

- Result of a decision taken by higher management, actively promote and encourage, evaluate the implementation
- Define clearly and positively the framework and objectives
- New system takes **time and money**, changes will affect current status quo – especially production and maintenance department – **speculation, resentment, resistance**, etc.
- Management need to consult staff and keep them “in the picture”

- Management needs to **appoint one person to lead**, control and co-ordinate.
- The person should be given;
 - Comprehensive briefing of policy
 - Boundaries of operation
 - Expected results
 - Program target date
 - Resources at his disposal
 - Authority to make decision
 - Power to carry out & responsibilities for the action

ITEM 2 : The Inventory

The inventory is a list of all facilities – all parts of a site, building and contents – for purpose of identification.

Establishing – **what** is to be maintained

- Should not depend entirely on old records
- Must be able to answer – What is actually there, **not** what should be there or what was thought to be there.

ITEM 2 : The Inventory

- Carry out a physical inventory – listing each item and marking its position on a block plan of the area.
 - Compiling inventory can provide better understanding of the individual items and overall production process.
 - Inventory sheet (form) should compile important information
 - Identification symbol
 - Description of facility
 - Location
 - Type
 - Priority Rating

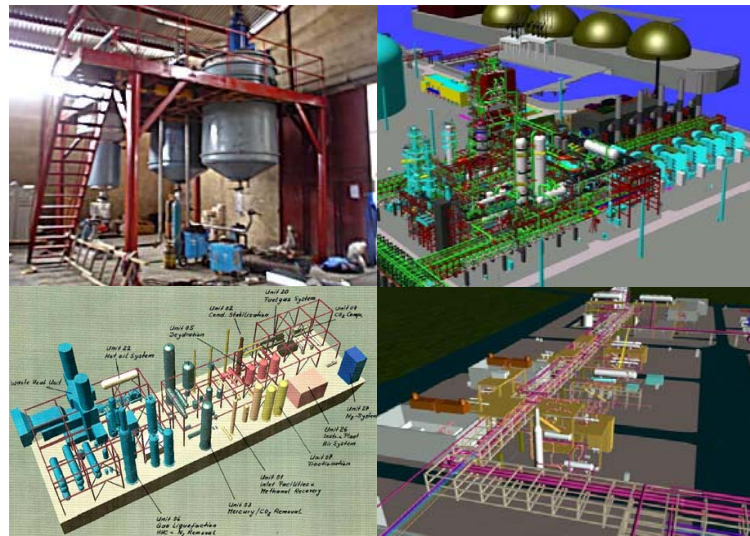
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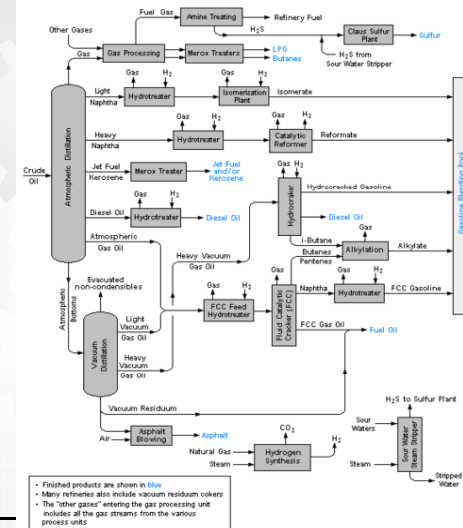
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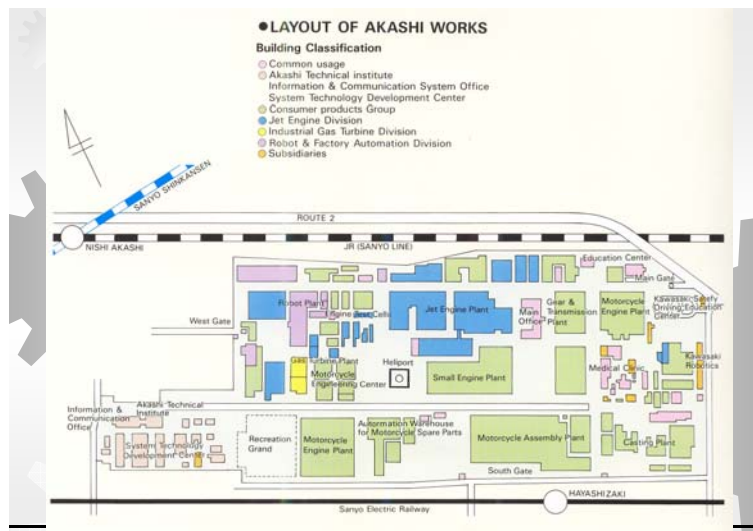
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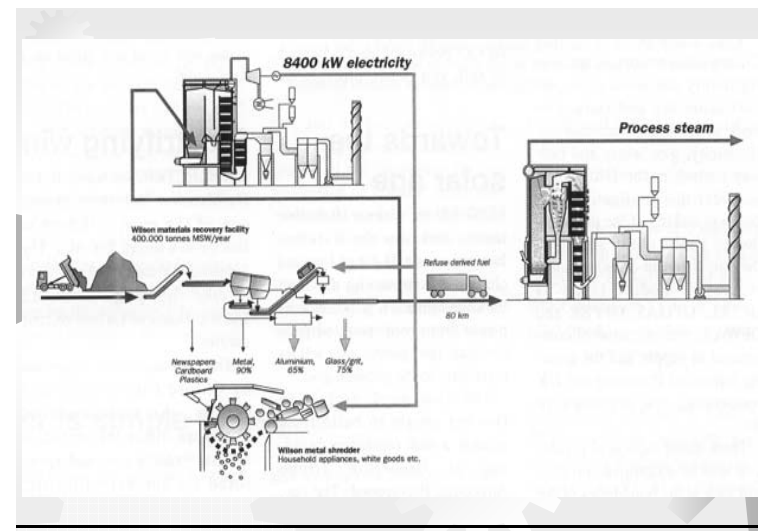
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ITEM 2 : The Inventory

Facility types

- Major mechanical plant – pumps, compressors, boilers
- Major electrical plants – transformers, breakers, switchgear, rectifier, main motors, starters.
- Minor mechanical plant – valves, hydraulic rams
- Minor electrical plant – small motors & starters,
- Instruments and instrumentation systems
- Pressure vessels, receivers, gas holders
- Lifting gear, lifting machines, hoists, lifts, jacks, cranes

ITEM 2 : The Inventory

Facility types

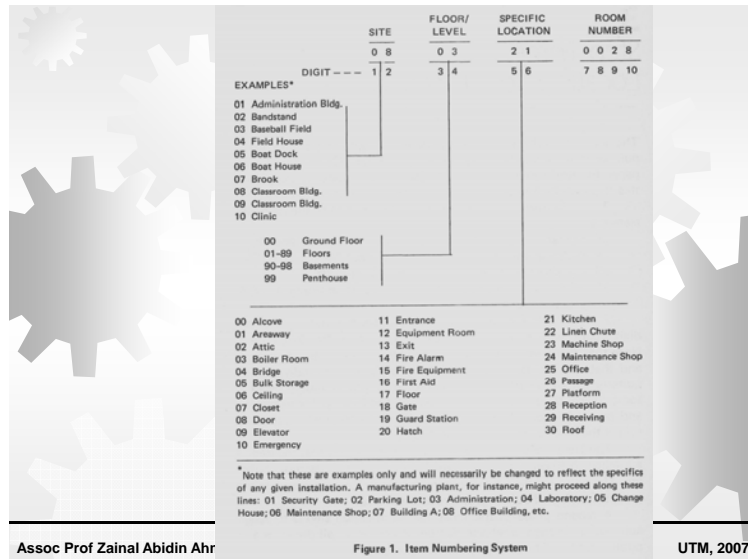
- Machine tools – lathes, milling, drilling, grinding machines.
- Fire fighting services – detection system, alarm system, extinguishers
- Factory & office services – heating & ventilation, air-conditioning systems, hot & cold water
- Vehicles or mobile plant – lorry, cars, trucks, dumpers, mobile pumps, compressors
- Major spares

ITEM 2 : The Inventory

Priority Rating

- No.1 – Safety hazard, vital to production process, immediate effect, failure of which would halt production.
- No. 2 – Failure of this item would not immediately affect production but could do so within a very short space of time.
- No. 3 & 4 – Similar to no 2, but in descending order of importance.
- No. 5 – Non productive items, no safety hazards.

INVENTORY SHEET					Sheet No.
Identification Symbol	Description of Facility	Location	Type	Priority Rating	Remarks
09-01-01	Centre lathe: Lang 13" swing Model J.6. Serial No 62 B/10	Maintenance work-shop	Machine tool	5	
09-91-01	Electric motor (driving lathe) Brookhirst Igranite Ltd No C11360/61/2: 5 h.p.	"	Electric (minor)	5	Type SC: 400/440 volts 3 phase: 50 cycles
09-03-01	Shaper "Invicta". Type 2M B. Elliott (Machinery) Ltd. London Serial No B.E.C. 19017/4	"	Machine tool	5	
09-91-02	Electric motor (driving shaper) Brook Motors. 3 h.p. No L131 651	"	Electric (minor)	5	A.C. class E. INT rating Frame C182: 1420 r.p.m. 400/440 V: 3 ph. 50 ~: 4.7 amp
09-02-01	Milling M/C (Universal) B. Elliott (Machinery) Ltd London Serial No B.E.C. 011236/120	"	Machine tool	5	
09-91-03	Electric motor (driving milling m/c) Newman. 3 h.p. Conn Diag No C123006 ED 30 25	"	Electric (minor)	5	Class F. 1425 r.p.m. 400/440 V: 3 ph. 50 ~ CMR rating: 4.9 amp Frame C184 DC. 1552 BB



ITEM 3 : Identification of Plant & Equipment

Identification symbols

- Positively identify each item, no possible doubt or mistake, easily locate
- To indicate the department, section, group or type of item for cost allocation purpose.
- Relate to documentation – instructions, records, job cards, specifications, reports, etc.
- In the forms of codes from colours, shapes, patterns, names, letters, numbers or combinations of any of them
- The use of letter and numbers is the best choice.

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ITEM 3 : Identification of Plant & Equipment

Marking the equipment

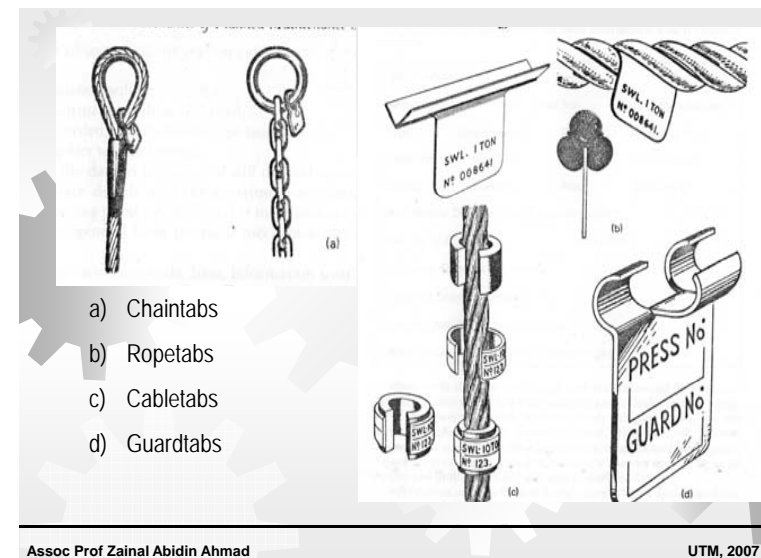
- Standardized throughout factory
- Easily visible, permanent, not causing obstruction, easily & quickly fixed, neat in appearance.

Means of identification

- Fulfilling statutory requirements
- Chaintabs, Ropetabs, cabletabs, guardtabs

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☀ ITEM 4 : The Facility Register

The Facility Register is a record of facilities, including technical details about each.

To be used as standard reference, confirming;

- The original specification, performance
- Manufacturers recommendation limits, fits, tolerances
- Assist the ordering of correct spares and replacements
- Provide necessary information when planning the movement, relocation, access, safe floor loading, layout of plant

- ☀ The value of this collection of data will be appreciated by those who have spent considerable time and trouble, often fruitlessly, searching for similar elusive details.

Identification No:		Location:	
Type of Facility:			
Manufacturer:		Date of Manufacture:	
Serial No:	Specification:	Size:	Model:
Capacity:		Speed:	
Total Weight:		Power and Service Requirements:	
Connection Details:	Foundation Details:	Overall Dimensions:	
Headroom, clearance and access dimensions:			
(a) For the withdrawal and maintenance of components.			
(b) For manoeuvrability through restricted openings, doorways, passages, gangways, etc.			
Reference drawing numbers:			
Reference numbers of service manuals:			
Interchangeability with other units:			

Identification No:		Location:	
Manufacturer:		Serial No:	Date of Manufacture:
Type:	Specification:	Rating:	Frame Size:
Power/kW:	Winding:	Speed:	Total Weight:
Voltage:	Current:	Phase:	Frequency:
Shaft details: Diameter, length, keyway, height:			
Bearings: D.E., N.D.E.,		Lubrication:	
H.D. bolts: Diameter and centres			
Reference Drawing Numbers:			
Interchangeability with other motors			
Identification number of associated starter gear:			

☀ ITEM 4 : The Facility Register

- ☀ The nature of data to be recorded will depend upon the type of facility. Name plate details and information from manufacturers' literature are a starting point.

- For a few pieces of equipment, simple office duplicated forms contained in loose-leaf binders or cards filed in drawers may be adequate.

- For extensive items, used tailored system.

- Fig 2.4 – 2.8
- Manually done, tedious, time consuming, subject to mistakes and omissions
- Computerized system would greatly facilitate the task

ENGINE CLEARANCE DATA

Details between which wear occurs	Designed Max. and Min. Clearance	Maximum allowable Clearance	Remarks
Crankshaft, end journal	.0025" to .0035"	.006"	Max. ovality of journals .003" (.076 m/m) Min. clearances may be reduced .0005" .012 m/m by 'Nip' when fitting bearings
Main Bearing, end	.064 m/m .089 m/m	.152 m/m	
Crankshaft, intermediate journal	.002" to .005"	.007"	Max. ovality of crankpin .003" .076 m/m Min. clearance may be reduced .0005" .012 m/m by 'Nip' when fitting bearings
Main Bearing, Intermediate	.051 m/m .127 m/m	.178 m/m	
Crankshaft End Float	1 Cyl. Engine .002" to .007" Multi Cyl. Engine .003" to .005"	.015" .010"	Maximum Liner wear .015" (.38 m/m) The Liner wear is more important because piston body wear is usually negligible
	.051 m/m .178 m/m .076 m/m .127 m/m	.38 m/m .254 m/m	
Crankpin Large End Bearing	.0015" to .004" .038 m/m .102 m/m	.006" .152 m/m	
Liner Piston Body (Cast Iron)	.004" to .0055" .102 m/m to .14 m/m	.008 (.203 m/m) on unworn section of liner	
Liner Piston Body (Alloy)	.0045" to .013" .114 m/m .33 m/m Piston oval and tapered	.009 to .016 .23 m/m to .41 m/m on unworn section of liner	

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IDENTIFICATION N°	LOCATION
MANUFACTURER	SERIAL N° YEAR
K.W.	R.P.M.
VOLTS CURRENT	PHASE WINDING
FRAME SIZE	MOUNTING
SHAFT DIA KEYWAY	LENGTH
BEARINGS-D.E.	N.D.E.
ASSOCIATED STARTER GEAR	LUBRICANT
ASSOCIATED EQUIPMENT	
INTERCHANGEABLE WITH MOTOR N°	

FACILITY CARDS FILED IN DRAWERS THE RESPECTIVE CATEGORIES SEPARATED BY DIVIDERS

2.4 A facility register and storage chest

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(front)

(back)

Kalamazoo mechanical card (back)

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2.5 Examples of facility record sheets for visible records systems

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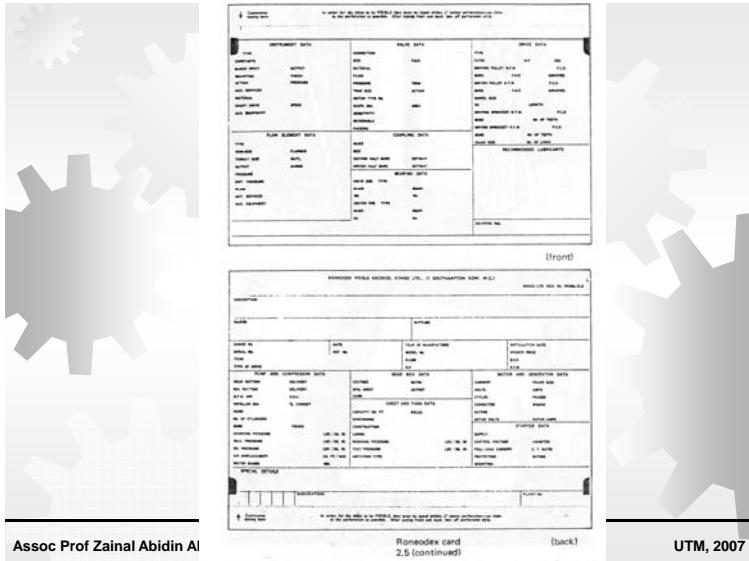
Kalamazoo mechanical card

Kalamazoo electrical card

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2.5 (continued)

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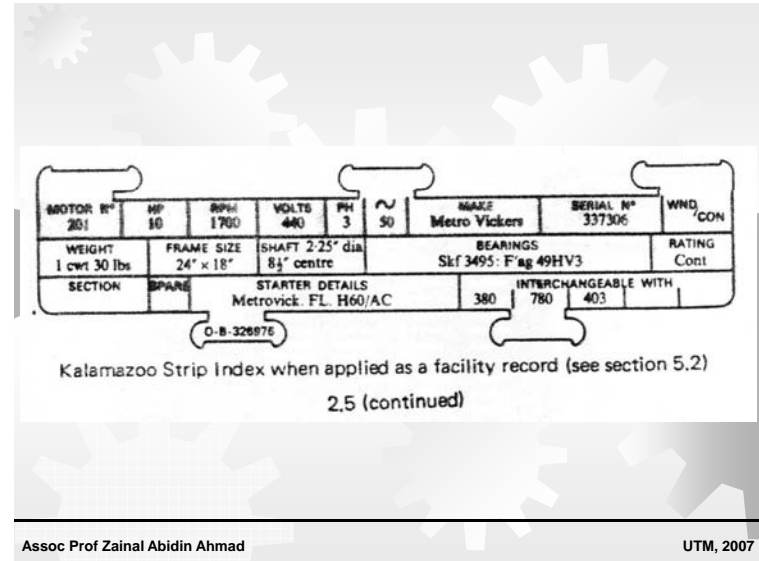


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Rolodex card

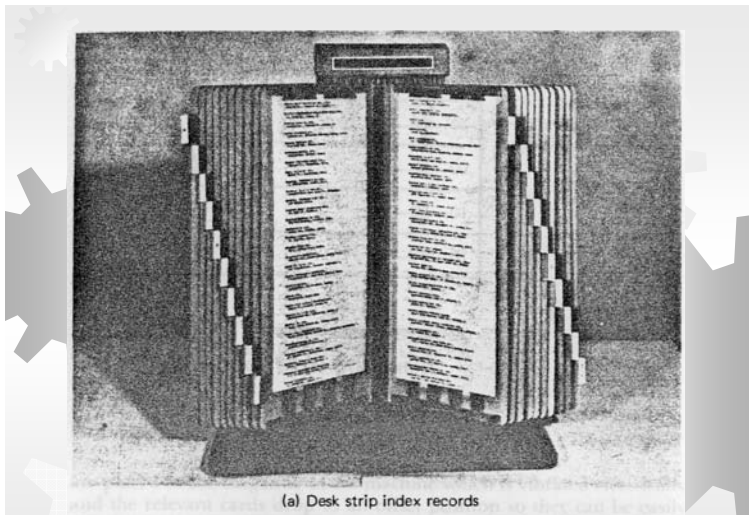
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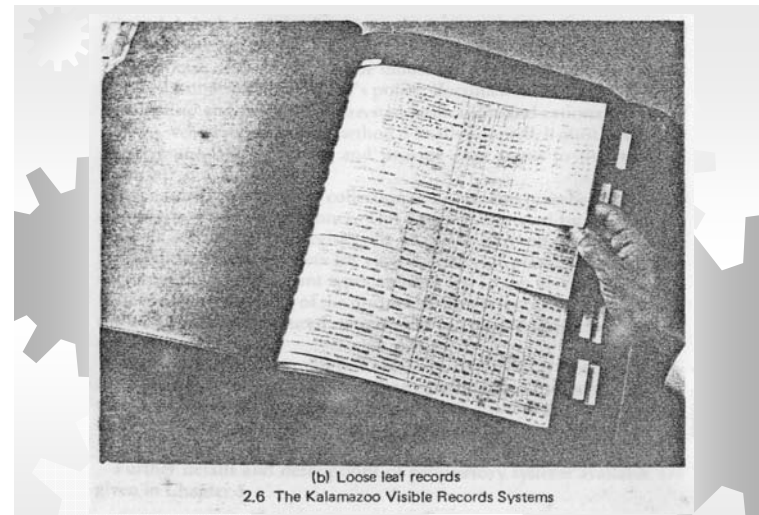
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(a) Desk strip index records

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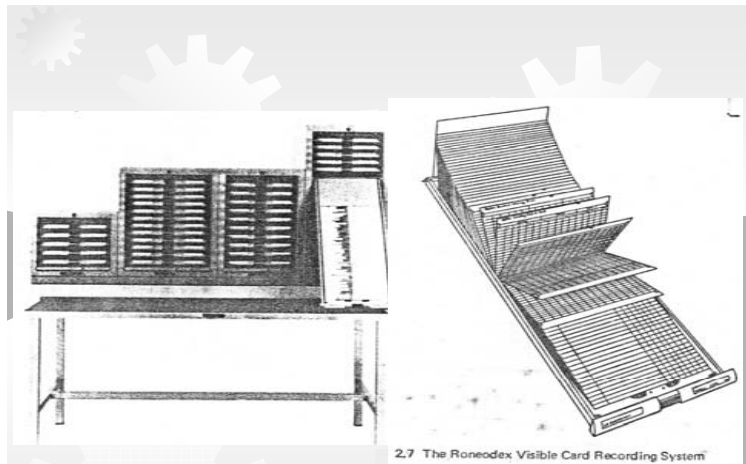
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(b) Loose leaf records
2.6 The Kalamazoo Visible Records Systems

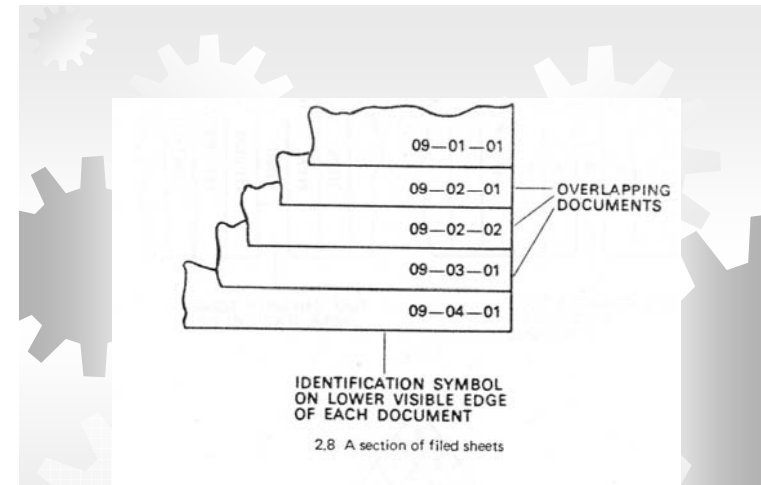
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● ITEM 5 : Maintenance Schedule

The maintenance schedule is a comprehensive list of maintenance and its incidence

- To answer the question of **How is it to be maintained.**
- All relevant tasks set out – inspection, lubrication, adjustment, component replacement, overhaul – together with the maintenance frequencies.
- Consider maintenance policy for each item – breakdown, preventive, priority rating, cost of repair.

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● ITEM 5 : Maintenance Schedule

- Make use of manufacturer's recommendations, previous experience, past records – plant log sheets, store records, cost sheets, time cards, etc.
- Extract information to analyse
 - Facilities, components, parts most frequently failed
 - Types and frequencies of failures
 - Result or effect of various types of failure
 - Conditions under which failures most frequently occur
 - Effect of time and conditions upon efficiency & performance
 - Time & cost needed to carry out maintenance, repair or replacement

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ITEM 5 : Maintenance Schedule

Extract information to analyse.....cont

- Components and materials used for maintenance, repair or replacement
- Tradesmen or contractor needed to carry out the work.
- Total cost of maintaining each facility
- Allowable limits of wear, temperature rise, pressure drop, etc
- Constraints imposed – legal, operational or safety obligations
- Safety practices and regulations to be observed
- Conditions when each facility is available for maintenance – any time, only when defect/breakdown occur, only when process shut down

ITEM 5 : Maintenance Schedule

Establish the maintenance frequencies

- Calendar time scale – weekly, monthly, quarterly, annually
- Operating time – running hours, operating cycles, miles traveled
- Calendar time easier to plan as compared with operating time.

ITEM 5 : Maintenance Schedule – Summary

The schedule consists of an individual sheet, card or a set of sheets/cards for each facility, indicating;

1. Name & identification number of item
2. Location of item
3. Reference number of the schedule
4. Safety procedures to be followed
5. Detailed list of tasks to be carried out
6. The frequency of the listed tasks must be carried out
7. Tradesmen or other personnel required
8. Time required to carry out the task
9. Special tools or equipment required
10. Materials, major components or replacements required.
11. When the facility is available for maintenance
12. Associated equipment or facilities that should be maintained simultaneously.
13. Details of any contract maintenance

MAINTENANCE SCHEDULE		Location:		Identification No of Facility		
Description of Facility "MBM" 15 kW Air Cooled Diesel Engine		Pump House		16-52-3		
Ref Drawing Nos		Schedule Ref. No		52693		
Service Manuals – Ref Nos 8234		Date Originated 25 April 1973		Modifications		
Associated Equipment Generator No 16-60-3		Date				
Item No.	Job Description	Availability Maintenance	Job Spec ⁿ Applicable for each Item	Trade	Time Required for each Item	Remarks
Daily – "A" Service						
1	Check level of fuel in service tank.	R		Lub ⁿ Op ^r	5 mins	S.E.A. 20
2	Check level of lubricating oil in sump.	R		Lub ⁿ Op ^r		
Weekly – "B" Service						
3	Clean oil bath air filter and top up with oil to the marked level.	S/D	45	Lub ⁿ Op ^r	30 mins	½ Litre S.E.A. 20
4	Drain fuel pump chamber or drain pot.		21	Lub ⁿ Op ^r		
5	Examine and, if necessary, oil the starting handle pawl and the portion of the shaft on which it fits.			Lub ⁿ Op ^r		
6	Lubricate the links and connections of all external controls.			Lub ⁿ Op ^r		
7	Check the tension of belts.		23	Mech Fitter	5 mins	
Two Monthly – "C" Service						
8	Inspect fuel filter elements. Renew if necessary.	S/D	47	Lub ⁿ Op ^r	1½ hrs	2 off No 62127 2 off No 36122 10 Litres S.E.A. 20
9	Renew lubricating oil filter elements.		48	Lub ⁿ Op ^r		
10	Drain lubricating oil sump, clean strainer, and refill with new oil.		53	Lub ⁿ Op ^r		
11	Clean lubricating oil filter gauze.		51	Lub ⁿ Op ^r		
12	Grind in the valves.		66	Mech Fitter	8 hrs	

Four Monthly – "D" Service					
13	Remove injectors, clean injector filter and test spray. Replace without interference if spray is satisfactory.	S/D	60	Mech Fitter	2 hrs
Six Monthly – "E" Service					
14	Renew fuel filter elements.		47	Lub ⁿ Op ⁿ	15 mins
15	If engine shows signs of loss of power, remove cylinder head and piston, examine and check wear with recommended maximum wear allowances. If engine is performing satisfactory DO NOT DISTURB.	S/D		Mech Fitter	
Annually – "F" Service					
16	Remove cylinder heads, examine inlet and exhaust valves, decarbonize, grind in valves.		70	Mech Fitter	
17	Withdraw and clean pistons, check that rings are free and the wear is within the recommended tolerance.		73	Mech Fitter	
18	Check and adjust valve and pump fuel tappet clearances.	S/D	71	Mech Fitter	
19	Examine large end bearings and check crankpins for ovality and scoring.		72	Mech Fitter	
20	Check fuel pump operating gear and governor for signs of undue wear.		76	Mech Fitter	
21	Clean exhaust ports, pipes and silencer.		75	Mech Fitter	
2 Yearly – "G" Service					
22	Examine main bearings and check crankshaft for ovality and scoring.		80	Mech Fitter	
23	Remove and examine lubricating oil pump.	S/D		Mech Fitter	
24	Flush out all fuel and lubricating oil pipes.			Lub ⁿ Op ⁿ	
25	Inspect cooling system for obstruction to the air flow, particularly in the area adjacent to the fan.			Mech Fitter	
26	Renew connecting rod bolts.			Mech Fitter	
<small>* R Running Maintenance S/D Shut down Maintenance</small>					

2.14 Maintenance schedule for a diesel engine

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ITEM 6 : Job Specification

The Job Specification is a document describing the work to be done

- The means of communicating the details to the person who will affect the work
 - Extract from maintenance schedule tasks
 - Check list forms
 - Manufacturers manuals

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ITEM 6 : Job Specification – to ensure

- The task or job is carried out in the manner intended
- The possibility of an operation being omitted is minimized.
- Acceptable limits of wear, etc and tolerances are clearly defined.
- The tradesman knows the work and how it is to be done.
- The operation is always carried in the same manner (standardization)
- All persons doing the work, even for the first time, follow the same procedure (continuity)
- A reference standard is available for reference.

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ITEM 6 : Job Specification – Summary

Each specification should indicate:

- The identification number and name of each item, location of item
- The maintenance schedule reference number of task
- Job specification reference number
- Frequency of task,
- Tradesmen required
- Specific details of the work to be done
- Components to be replaced
- Special tools and equipment to be used
- Reference drawing, manual, etc
- Safety procedures to be followed

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BP FLEETCARE		OPERATOR:		INSPECTION LIST			
VEHICLE TYPE	REG. No.	FLEET No.	SPEEDO Rdg.	DATE in	DATE out	OK	REPAIR REQ
VEHICLE SHOULD BE CLEAN BEFORE INSPECTION							RECTIFIED
No	ITEM	CHECK	REMARKS	No.			
EXTERIOR INSPECTIONS							
1	Position of Legal Plate	Presence, Security, Prominence		1			
2	Details of Legal Plate	Legibility, Correct for vehicle		2			
3				3			
4				4			
5	Smoke Emission	Density		5			
6	Road Wheels & Hubs	Fractures, Distortion, Security		6			
7	Size & Type of Tyres	Size, Ply, Mixing of Tyres		7			
8	Condition of Tyres	Damage, Tread Depth & Width, Walls		8			
9	Bumper Bars	Security, & Condition		9			
10	Spare Wheel Carrier	Security, Condition, Wheel Security		10			
11	Trailer Coupling	Security, Wear, Safety Device, Deform'n		11			
12	Coupling on Trailer			12			
13				13			
14	Condition of Wings	Presence, Damage, Security, Fouling		14			
15	Cab Mountings	Security, Condition, Locking Devices		15			
16	Cab Doors	Presence, Condition, Security, Operation		16			
17	Cab Floor & Steps	Security, Condition		17			
18	Driving Seat	Security, Condition, Adjustment		18			
19	Security of Body	Displacement, Security		19			
20	Condition of Body	Overall Condition, Safety, Security, Leaks		20			
21				21			

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21				21
INSIDE CAB INSPECTIONS				
22	Mirrors	Presence, Condition, Posn., Security		22
23	View to Front	Obstruction		23
24	Condition of Glass	Visibility, Cracks		24
25	Windscreen Wipers	Presence, Function, Condn., Wiping Area		25
26	Speedometer	Presence, Drivers View, Function, Illum.		26
27	Audible Warning	Presence, Control Posn., Secty., Function		27
28	Driving Controls	Completeness, Condition, Posn., Obstructn		28
29				29
30	Play at Steering Wheel	Not more than one fifth of diameter		30
31	Steering Wheel	Security to Shaft, Condition		31
32	Steering Column	End Float, Side Play, Flex Coupling		32
33				33
34	Air/Vacuum Warning	Presence, Visibility, Operation, Reserve		34
35	Build-up of Air/Vacuum	Time required to operate warning		35
36	Mech. Brake Hand Levers	Condn., Travel, Obstruction, Hold on.		36
37	Service Brake Pedal	Condn., Secty., Travel, Obstruction, Antislip		37
38	Service Brake Operation	Leaks, Servo, Operation		38
39	Air/Vac Hand Controls	Secty., Condition, Travel, Leakage		39
40				40

*NOT APPLICABLE TO TRAILERS
BP/210/70

2.15 A check list type of specification

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5000 MILE INSPECTION

WORKS/DEPOT: _____ MAKE: _____ FLEET No. _____ DATE: _____

SPEEDO READING: _____ LAST INSPECTION DATE: _____ MILEAGE SINCE LAST INSPECTION: _____

CODING: IN ORDER REPAIRS REQUIRED IMMEDIATE REPAIRS

<p>STEERING</p> <p>Check <input type="checkbox"/> Play at steering wheel.</p> <p><input type="checkbox"/> Security of column and box.</p> <p><input type="checkbox"/> Clearance of steering arms throughout travel.</p> <p><input type="checkbox"/> Security of drop arm and method of locking.</p> <p><input type="checkbox"/> Wear of steering joints.</p> <p><input type="checkbox"/> Security of steering arms and method of locking.</p> <p><input type="checkbox"/> Wear in swivel pins and thrust races.</p> <p><input type="checkbox"/> Adjustment of lock stops.</p> <p><input type="checkbox"/> Wheel alignment.</p>	<p>TRANSMISSION</p> <p>Check <input type="checkbox"/> Gearbox mounting.</p> <p><input type="checkbox"/> Clutch adjustment, clutch cross-shaft, clevis pins.</p> <p><input type="checkbox"/> Gearbox coupling flange and flange bolts.</p> <p><input type="checkbox"/> Speedometer drive and cable.</p> <p><input type="checkbox"/> Gear change mechanism and linkage.</p> <p><input type="checkbox"/> Propeller shaft, universal joints.</p> <p><input type="checkbox"/> Propeller shaft intermediate bearings and mountings.</p> <p><input type="checkbox"/> Differential housing, cover plate and oil filler bolts for security and oil seals.</p> <p><input type="checkbox"/> Differential drive oil seals.</p> <p><input type="checkbox"/> Drive shaft studs.</p> <p><input type="checkbox"/> Drive shaft oil seals.</p> <p><input type="checkbox"/> Differential lock operating pipes.</p>
<p>BRAKES</p> <p>Check <input type="checkbox"/> If brakes operate correctly.</p> <p><input type="checkbox"/> Braking system for leaks with footbrake applied.</p> <p><input type="checkbox"/> Build up of vacuum or air pressure satisfactory.</p> <p><input type="checkbox"/> Brake warning gauge and/or device working.</p> <p><input type="checkbox"/> Security of brake pipes, servos or reservoir.</p> <p><input type="checkbox"/> Wear in connections.</p> <p><input type="checkbox"/> Security of clevis pins.</p> <p><input type="checkbox"/> Wear in pedal pivot bush.</p> <p><input type="checkbox"/> Wear in handbrake pivot bush, ratchet and pawl.</p> <p><input type="checkbox"/> Wear on brake liners.</p> <p><input type="checkbox"/> Flexible pipes – wear, chafing or weeping.</p> <p><input type="checkbox"/> Handbrake cable fraying.</p> <p><input type="checkbox"/> Hydraulic reservoir fluid level.</p> <p><input type="checkbox"/> Correct adjustment foot and handbrake.</p>	<p>ELECTRICAL</p> <p>Check <input type="checkbox"/> Battery secure and terminals clean.</p> <p><input type="checkbox"/> Security of terminals and wiring clips.</p> <p><input type="checkbox"/> Headlamps, sidelamps, rear lights, stoplights, spotlights, indicator lights, horn and wipers.</p> <p><input type="checkbox"/> Charging rate. Lamp focus switches.</p>
	<p>FRAME</p> <p>Check <input type="checkbox"/> Freedom from cracks, visibly true.</p> <p><input type="checkbox"/> Security of rivets and bolts.</p> <p><input type="checkbox"/> Security of all frame brackets.</p> <p><input type="checkbox"/> Serviceability of registration plates and reflectors.</p>

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<p>WHEELS AND TYRES</p> <p>Check <input type="checkbox"/> Wheel nuts and studs.</p> <p><input type="checkbox"/> Wheels for cracks or broken flanges.</p> <p><input type="checkbox"/> Wheel bearings for wear.</p> <p><input type="checkbox"/> Tyres for cuts and irregular wear.</p>	<p>CAB AND BODY</p> <p>Check <input type="checkbox"/> Mounting brackets and pads.</p> <p><input type="checkbox"/> Soundness of cab structure.</p> <p><input type="checkbox"/> Security of doors, locks, windcreens, windows and lights.</p> <p><input type="checkbox"/> Security of driver's seat.</p> <p><input type="checkbox"/> Soundness of cab floor boards.</p> <p><input type="checkbox"/> Fittings and serviceability of mirrors.</p> <p><input type="checkbox"/> Soundness and security of mudguards.</p> <p><input type="checkbox"/> Security of body mounting.</p> <p><input type="checkbox"/> Taper ram mounting, hinge bar and brackets, tip gear.</p> <p><input type="checkbox"/> Oil reservoir.</p> <p><input type="checkbox"/> Ram seals.</p> <p><input type="checkbox"/> Neutral control valve.</p> <p><input type="checkbox"/> Pump engagement.</p> <p><input type="checkbox"/> Power take-off.</p> <p><input type="checkbox"/> Drive shaft.</p> <p><input type="checkbox"/> Driveline bearing.</p> <p><input type="checkbox"/> Drive belts and pulleys.</p> <p><input type="checkbox"/> Air filter.</p> <p><input type="checkbox"/> Pipework and valves.</p>
<p>EXHAUST</p> <p>Check <input type="checkbox"/> Security and leaks.</p> <p><input type="checkbox"/> Density of exhaust smoke.</p>	<p>ENGINE</p> <p>Check <input type="checkbox"/> Cooling system, hose pipes, clips and fan.</p> <p><input type="checkbox"/> Belt adjustment, radiator cap, overflow, pipe, water circulation, water pump, radiator mountings.</p> <p><input type="checkbox"/> Engine mountings, inlet and exhaust manifolds, exhaust pipe security.</p> <p><input type="checkbox"/> Fuel pump mounting, fuel pump drive.</p> <p><input type="checkbox"/> Fuel pipes, injector pipes, return pipes, filters.</p> <p><input type="checkbox"/> Accelerator controls, venturi pipes, stop/start control.</p> <p><input type="checkbox"/> Starter and dynamo mounting.</p> <p><input type="checkbox"/> Tappets.</p> <p><input type="checkbox"/> Brake compressor or exhauster.</p> <p><input type="checkbox"/> Power steering pump, oil reservoir, steering oil pipes.</p> <p><input type="checkbox"/> Engine performance for excess fuel consumption, pump timing, defective injectors.</p> <p><input type="checkbox"/> Engine oil, oil filters and air filters.</p>
<p>SPRINGS</p> <p>Check <input type="checkbox"/> Security of axle bolts, lock nuts and spring clips.</p> <p><input type="checkbox"/> Broken or displaced leaves.</p> <p><input type="checkbox"/> Wear in shackles, pins and bushes.</p> <p><input type="checkbox"/> Security of hangers to chassis frame.</p> <p><input type="checkbox"/> Balance beam trunnions for wear.</p>	
<p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p>	<p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p> <p>M/M</p>
<p>TYRE TREAD DEPTH M/M</p>	
<p>REPORT DEFECTS OVERLEAF</p>	<p>WORK CHECKED & CLEARED</p>

2.17 An example of a job specification for the periodic maintenance of a motor vehicle

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JOB SPECIFICATION No 73

'Withdraw and clean pistons, check that rings are free and the wear is within the recommended tolerances.'

TO WITHDRAW PISTON

1. Remove cylinder heads Job Specification No 70
2. Uncouple connecting rod big end and bearing, Job Specification No 79
3. Lift piston and connecting rod from cylinder.
4. Remove gudgeon pin.

To assist removal immerse piston assembly in hot oil, or stand piston on hot plate.

TO REMOVE PISTON RINGS

5. Soak piston assembly in paraffin to soften carbon deposits.
6. Spring open rings and insert thin metal strips between the rings and piston at four different points.
7. Remove rings by sliding them over the metal strips.
8. Thoroughly clean pistons and rings. Flush through oil holes and passages with syringe using paraffin.

CHECK DIMENSIONS OF ALL RINGS

9. Check gap. (Pressure and Scraper rings similar.)

Each ring must be checked and measured in the same cylinder bore from which it was removed.
In the case of new rings measurements must be made in the cylinder the ring will eventually occupy.
Check gap at unworn portion of the liner.
Insert ring squarely in cylinder bore.
Use Jig No 1052 to locate.

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10. Measure gap with feelers.

Designed gap size	{ 0.25 mm to 0.38 mm 0.010" to 0.015"
Renew ring when gap reaches	{ 0.76 mm 0.03"
11. Replace each ring back into its original piston groove.
Use the thin metal strips to slide rings over piston.
12. Check clearance between piston ring groove and piston ring edge.

Designed clearance	{ 0.025 mm to 0.073 mm 0.001" to 0.003"
Renew ring when clearance exceeds	{ 0.2 mm 0.008"

NOTE: If designed clearance cannot be obtained with new standard ring, open out groove and fit over-width ring.

CHECK GUDGEON PIN AND SMALL END BUSH

13. Designed clearance

	{ 0.04 mm to 0.064 mm 0.0015" to 0.0025"
Renew when clearance exceeds	{ 0.1 mm 0.004"

REFIT GUDGEON PIN AND CONNECTING ROD TO PISTON

14. Immerse piston in hot oil or stand on hot plate to ease insertion of pin into piston.

REPLACE PISTON

15. Smear lubricating oil on piston piston and liner.
16. Stagger piston ring gaps.
17. Using Jig No 1056 to hold in piston rings, slide piston into liner.
18. Couple connecting rod big end and bearing. Job Specification No 79
19. Replace cylinder heads. Job Specification No 70.

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FACILITY IDENTIFICATION N°	MAINTENANCE SCHEDULE REF N° ITEM N°	JOB SPECIFICATION N° STANDARD 69-1
FACILITY DESCRIPTION STEAM STOP VALVE	JOB DESCRIPTION:- OVERHAUL OF STEAM STOP VALVE	
LOCATION :- ALL STEAM LINES ON SITE	TRADE :- MECH FITTER	FREQUENCY :- ANNUALLY
<ol style="list-style-type: none"> 1. OBTAIN Permit-to-Work. 2. Shut off the two Steam Stop Valves on each side of valve to be overhauled. Secure in the closed position with lock and chain. 3. Allow time for line steam pressure to drop to zero. 4. Remove valve stem cover. Fit blocks to open ends of line if no replacement valve is available. 5. Remove bridge cover nuts and withdraw cover, gaskets, and valve lid. 6. Disassemble gland, gland packing, headnut, spindle and valve lid. 7. Examine the following components: GLAND for bedding and seating. VALVE SPINDLE in way of packing and of screw thread. Check for work. BRIDGE COVER nuts - check for wear and with valve spindle for fit and movement. VALVE LID FACE for warping and pitting, measure if necessary. STUDS on valve about the headnut and fit, because near the headnut. VALVE SEAT FACE for warping and pitting, measure if necessary. VALVE CHEST FLANGES for condition and damage. 8. Compare dimensions of valve seat, valve lid, and spindle with manufacturers drawings. All spindles, valves, etc., to be brought back to drawing dimensions or oversized. 9. Water test valve about to make working pressure. 10. Assemble valve and valve seat to make working pressure. 11. Remove blocks and replace valve in line. 12. Remove blocks and blocks on adjacent stop valves. 13. RETURN Permit-to-work. 		
DRAWINGS REQUIRED		
SPECIAL TOOLS REQUIRED		
OBSERVE SAFETY REGULATIONS		CLEAR SITE ON COMPLETION

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- **ITEM 7 : The Maintenance Program**
The maintenance program is a list allocating specific maintenance to a specific period
- Having established **what** is to be maintained, and **how** it is to be maintained, we must now consider **when** it is to be maintained.
- The main purpose of the program
 - To set out a plan of work
 - To spread the maintenance work load evenly over a year
 - To ensure that no facility or maintenance task is omitted
 - To ensure that the required maintenance is carried out at the specified frequency
 - To coordinate the maintenance of associated facilities
 - To coordinate maintenance with production requirements.

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ITEM 7 : The Maintenance Program

The main purpose of the program.....cont

- To present an overall picture of maintenance work, present and future commitments (short & long term)
 - To assist forward planning, ordering of spares, future labour requirements, basis of budgetary control
- To act as a reminder of future maintenance events (short term)
 - To formulate weekly work plan (for immediate future)
 - To arrange for availability of production plant
 - To arrange or check availability of labour, spares, sub-contractors, etc

ITEM 7 : The Maintenance Program

- The program should be prepared in consultation with the production department which is able to advise on production schedules and plant availability
- **Planning charts or board** – time scale. Use together with colour coded pins, pegs or crayons to represent the various maintenance operations, the work in progress and future commitments are depicted clearly.
- **Visible Record Cards** – can be a separate card or sheet or can use the facility register cards.

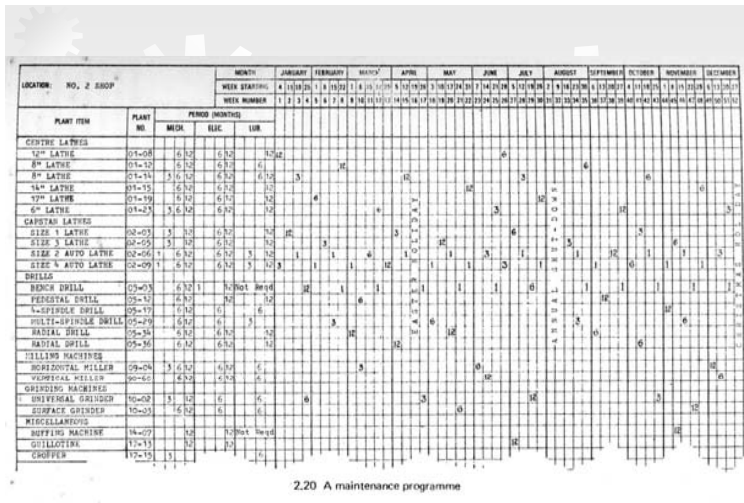
ITEM 7 : The Maintenance Program

Unexpected breakdowns will occur occasionally, but no necessary to divert labour to deal wit it immediately. Needs to rate the faults and breakdowns to a priority scale, thereby knowing the relative importance. Example of breakdown rating is;

- A – must be repaired immediately – safety hazards or immediately affecting production process.
- B – Must be repaired within 1 day
- C – Must be repaired within 3 days
- D – Must be repaired within 1 week
- E – Can be carried out at the first available opportunity.

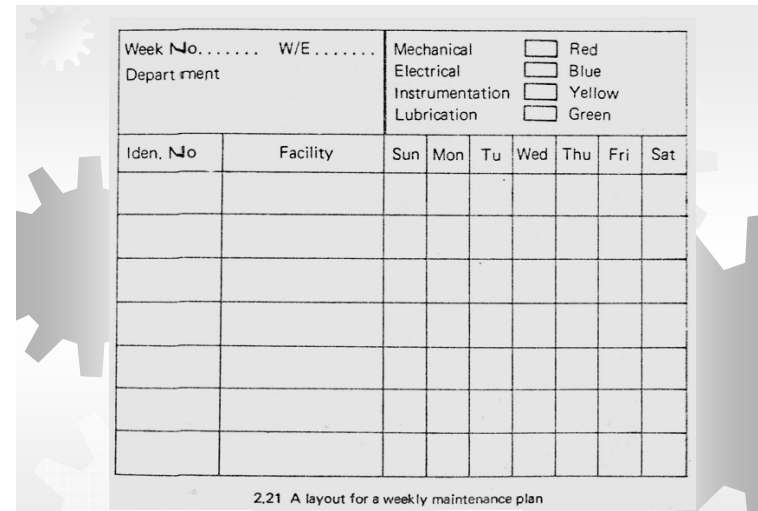
Work Request and Priority Guidelines

Priority	Example of Failure or Incident	Maximal time in backlog
Is the job necessary to do? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> On Hold		
1	Immediate safety risk Immediate risk of environmental damage Immediate risk of quality losses. Critical equipment down	Immediately. Will break other less important ongoing work.
2	Critical equipment is running at reduced speed Critical equipment is running in manual mode Manageable safety risk PM activity Mandatory inspections	1 day - 1 week
3	Critical equipment running on spare equipment Failures that need correction Spare equipment out of function Leaks	1 week – 1 month
4	Improvement work - expense. Improvement work - capital	> 1 month



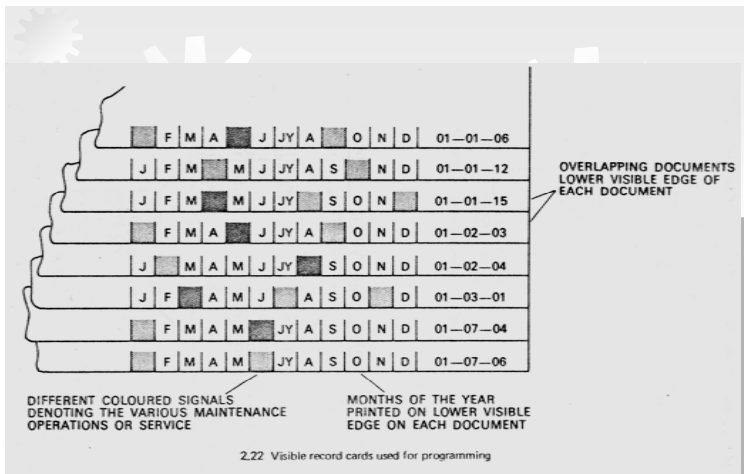
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2.23 A Planned Maintenance Program

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MAINTENANCE WORK ORDER NO. _____

DATE _____ TIME/RECD _____ DISPATCHER _____

CALLER _____ DEPT. _____ TEL. NO. _____

DESCRIPTION OF WORK _____

WHAT _____

WHERE _____

WHEN IS START REQUESTED _____ (ACTUAL START) _____ (FINISH) _____

CRAFTSMEN ASSIGNED (NAME) _____

JOB COMPLETION ACCEPTANCE (NAME) (CUSTOMER) _____ (MAINT. SUPERVISOR) _____

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a Planned Maintenance Program

WORK REQUEST / JOB ORDER / UNPLANNED NO. _____

REQUESTER _____ DEPARTMENT _____ REQUESTER NAME _____ (TITLE) _____ (TEL. NO.) _____ (DATE OF REQUEST) _____

ITEM TO BE WORKED ON _____

LOCATION OF ITEM _____ (BUILDING/FLOOR/ROOM/PARKING LOT/ETC)

DESCRIPTION OF WORK _____

LABOR COST _____ MATERIAL COST _____ JOB COST (TOTAL) _____ LIST DRAWINGS REFERENCES COMMENTS: _____ SPECIAL TOOLS OR EQUIPMENT REQUIRED: _____ PERMITS REQUIRED: _____ (COORDINATE WITH DEPT.) _____ PERSON TO CONTACT (TITLE, NO.) (DATE) (CONTACT BY YOUR NAME) _____ MATERIAL REQUIRED _____	IN STOCK _____ MUST ORDER E.T.A. P.O. NO. _____ LOCAL PICKUP _____	WORK FLOW DATE ASSIGNED _____		GAILY (DO NOW) _____	SCHEDULED _____	DEFERRED (HOLD) _____	CONTRACTED _____
		ACTUAL DATE OF WORK _____		STARTED - COMPLETED			
		EST. HOURS	ACT. HOURS	CRAFT ASSIGNED	NO.		

CARRIER/TECH. CONTROL TECH. ELECTRICIAN ELECTRONIC TECH. (GROUND)SMAN H.V.E. LOCK SMITH LABOR SERVICE MACHINIST MASON MECHANIC EQUIP MECHANIC VEH MILL/DRIFT PAINTER PLUMBER WELDER EQUIPMENT OPERATOR ACTUAL NAMES ON BACK OF FORM

(CUSTOMER ACCEPTANCE) (NAME) _____ (DATE) _____

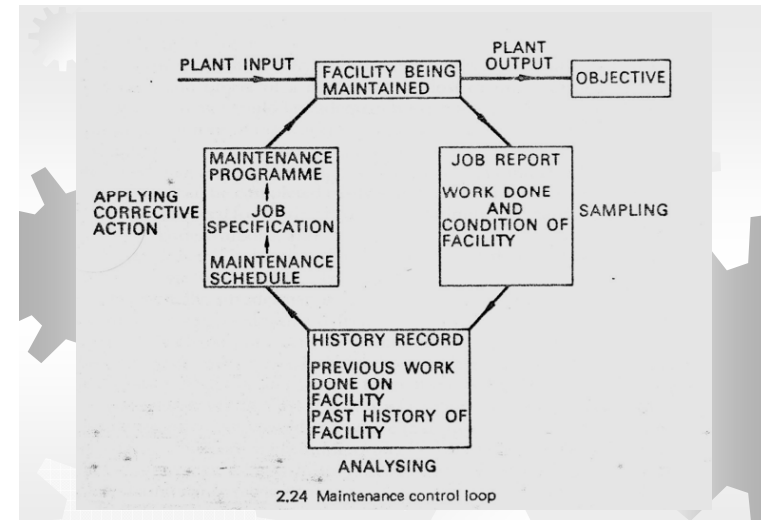
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- **ITEM 8 : The Control Cycle**
- The control of PM system depends upon monitoring the results, and if needed, perform corrective action.
 - Sampling the effect of maintenance – job report
 - Analysing the effect of of maintenance – history card
 - Applying corrective action – maintenance schedule, job specification & maintenance program (revise as necessary)

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ITEM 9 : Job Report

The job report is a statement recording the work done and the condition of the facility

- PM scheme will be effective if there is a continuous flow of information to and from the person(s) doing the work. This feedback is essential for the control and adjustment of the plan.
- Verbal reports are not reliable since they become forgotten or distorted.
- The report should include information concerning;
 - Work carried out, corrective action taken, component replaced
 - Defects found, corrected and their cause
 - Defect observed but not corrected
 - Time taken to complete the job
 - General observation, condition of the facility

ITEM 9 : Job Report

Job report should be designed such that

- It can be completed easily with minimum mental effort
- The need for writing is kept to a minimum – use code or symbols
- It is self indicative of any work or item that has been omitted.

Job Report	Date	Report No
Name of Tradesman	Clock No	Trade
Details of Report		
Item:		
Defect/condition:		
Result:		
Corrective action:		
Spares/materials used:		
Measurements/observations		
Remarks:		
Time taken:		
Facility	Location	Identification No

2.25 A job report

FACILITY IDENTIFICATION N°	MAINTENANCE SCHEDULE REF N°	JOB SPECIFICATION N°
FACILITY DESCRIPTION	JOB DESCRIPTION	STANDARD 87--3
PIPE-LINE BENDS	CHECK PIPE-LINE BENDS FOR WALL THICKNESS	
LOCATION: ALL PIPE LINES ON SITE	TRADE: PIPE FITTER	FREQUENCY: ANNUALLY
PIPE LINE N° ...	BEND N° ...	
APPLY D-METER AT THE NUMBERED TEST POSITIONS AND RECORD THE READINGS OBTAINED IN THE APPROPRIATE PANELS ON THIS REPORT FORM		
NOTE:- THE TEST POSITIONS ARE INDICATED BY YELLOW PAINT CIRCLES 25 mm dia. THE POSITION NUMBERS ARE DESIGNATED BY BLACK NUMERALS PAINTED IN THE MIDDLE OF THE CIRCLES.		
DRAWINGS REQUIRED		DATE
SPECIAL TOOLS REQUIRED		SIGNED
OBSERVE SAFETY REGULATIONS		CLEAR SITE ON COMPLETION

2.26 A job specification/report. Note: any reading omitted is self indicative

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*Terima Kasih
Thank You
Domo Arigato*