SOUTH CENTRAL RAILWAY

SUPERVISORS TRAINING CENTRE

SECUNDERABAD

*

WORK SHOP THEORY MWT- 01

STUDY MATERIAL

FOR

MSE-W (APP.SSE/WORKSHOP), MJR-W (APP.JE/WORKSHOP)

*

COMPILED BY
FACULTY OF STC/SC

SUBJECT NAME	WORKSHOP THEORY – 01
SUBJECT CODE	MWT – 01
MODULE	MSE – W, MJR - W

Lesson Code No.	Topics	Duration in hrs
1	Organization setup of Railway from board of workshop	03
2	Function of each department in short	03
3	Layout of workshop with important facilities for each shop functions	06
4	Role of workshop, different shops and its functions in brief	12
5	Role of Supervisors in workshops and their responsibilities	03
6	Material Handling Methods and Equipments	06
7	Machinery and Plants Maintenance	12
8	Jigs, Fixtures and Gauges	12
9	Quality Management system(QTM) & TQM	12
10	ISO & EMS systems in workshops	12
11	Value Engineering, Types of needs and demands	03
12	Production, Planning and Scheduling	06
13	Process Inventory Control	06
14	Industrial Safety Requirement & Procedure	06
15	Drawing usage, Preparation, Modification & its record maintenance	03
16	Revision	03
	Total	108

LESSON NO. 1
ORGANIZATION SET UP OF RAILWAY FROM BOARD TO WORKSHOP

Indian Railways runs one of the most complex rail networks in the world. It manages a network of over 67,312 route km with over 13.34 lakh employees. Approximately 20,038 trains runs daily out of which 12,617 are Passenger trains.

Railway Board:

Indian Railways are owned and managed by Government of India. Ministry of Railways of Government of India is headed by a Minister of Railways assisted by one or two Deputy Ministers. Administration and management of Indian Railways vests with the Railway Board – a top executive body- under the Minister of Railways. Railway Board exercises powers of Central Government in respect of regulation, construction, maintenance and operation of the Railways.

Railway Board is headed by a Chairman, Financial Commissioner and 5 members each representing a major department of Indian Railways – Member Staff, Member Electrical, Member Mechanical, Member Traffic, Member Engineering.

Financial Commissioner for Railways is vested with full powers of the Government of India to sanction Railway expenditure and is ex-officio Secretary to the Government of India in the Ministry of Railways in financial matters.

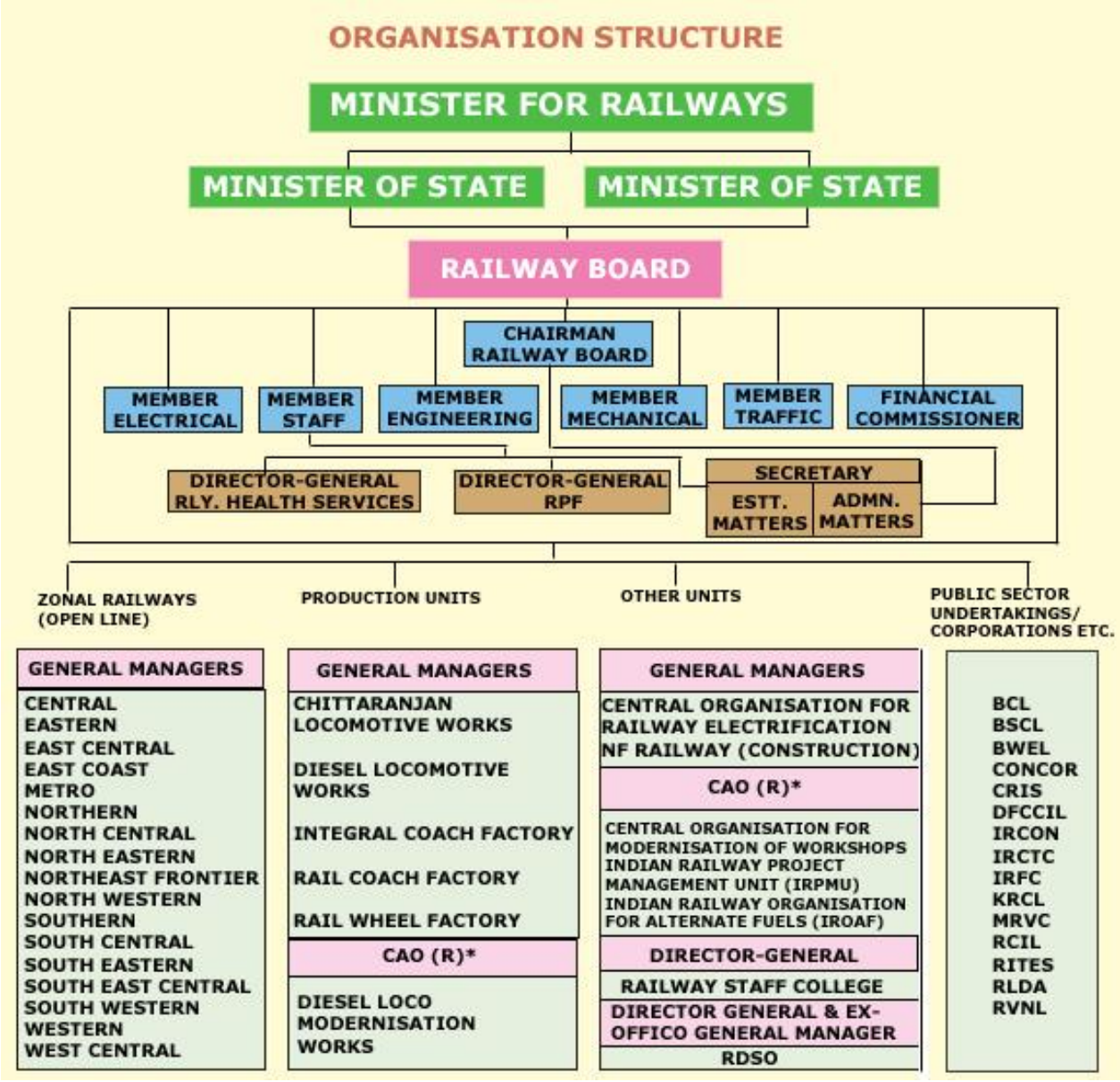
Railway Board is assisted by Director General/ Railway Health Services by Director General/Railway Protection Force & Security and some advisors.

Railway Board establishment is organized as functional directorates, each under an Executive Director who is responsible for the day to day technical and professional business of the Indian Railways as the per the policy guidelines laid out by the Board.

The entire secretariat is supervised by Secretary, Railway Board who is the coordinating officer between different directorates.

Executive Directors are in Senior Administrative Grade (SAG), Directors/Joint Secretaries in Selection Grade, Join Directors/ Dy. Secretaries in Junior Administrative Grade (JAG) and Dy Directors/ Under Secretaries in Senior Scale.

In 2003 Government of India through a notification made Railway Board a completely independent body which empowered it to take decision on projects without going through the Railway Ministry. Necessary checks have been made in the form of a body comprising of existing Board members, expenditure secretary and Secretary, Planning Commission.


ORGANISATION STRUCTURE
MINISTER FOR RAILWAYS
MINISTER OF STATE
MINISTER OF STATE
RAILWAY BOARD
CHAIRMAN RAILWAY BOARD
MEMBER ELECTRICAL
MEMBER STAFF
MEMBER ENGINEERING
MEMBER MECHANICAL
MEMBER TRAFFIC
FINANCIAL COMMISSIONER
DIRECTOR-GENERAL RLY. HEALTH SERVICES
DIRECTOR-GENERAL RPF
SECRETARY
ESTT. MATTERS
ADMN. MATTERS
ZONAL RAILWAYS (OPEN LINE)
PRODUCTION UNITS
OTHER UNITS
PUBLIC SECTOR UNDERTAKINGS/ CORPORATIONS ETC.
GENERAL MANAGERS
CENTRAL
EASTERN
EAST CENTRAL
EAST COAST
METRO
NORTHERN
NORTH CENTRAL
NORTH EASTERN
NORTHEAST FRONTIER
NORTH WESTERN
SOUTHERN
SOUTH CENTRAL
SOUTH EASTERN
SOUTH EAST CENTRAL
SOUTH WESTERN
WESTERN
WEST CENTRAL
GENERAL MANAGERS
CHITTARANJAN LOCOMOTIVE WORKS
DIESEL LOCOMOTIVE WORKS
INTEGRAL COACH FACTORY
RAIL COACH FACTORY
RAIL WHEEL FACTORY
CAO (R)*
DIESEL LOCO MODERNISATION WORKS
GENERAL MANAGERS
CENTRAL ORGANISATION FOR RAILWAY ELECTRIFICATION
NF RAILWAY (CONSTRUCTION)
CAO (R)*
CENTRAL ORGANISATION FOR MODERNISATION OF WORKSHOPS
INDIAN RAILWAY PROJECT MANAGEMENT UNIT (IRPMU)
INDIAN RAILWAY ORGANISATION FOR ALTERNATE FUELS (IROAF)
DIRECTOR-GENERAL
RAILWAY STAFF COLLEGE
DIRECTOR GENERAL & EX-OFFICO GENERAL MANAGER
RDSO
BCL
BSCL
BWEL
CONCOR
CRIS
DFCCIL
IRCON
IRCTC
IRFC
KRCL
MRVC
RCIL
RITES
RLDA
RVNL

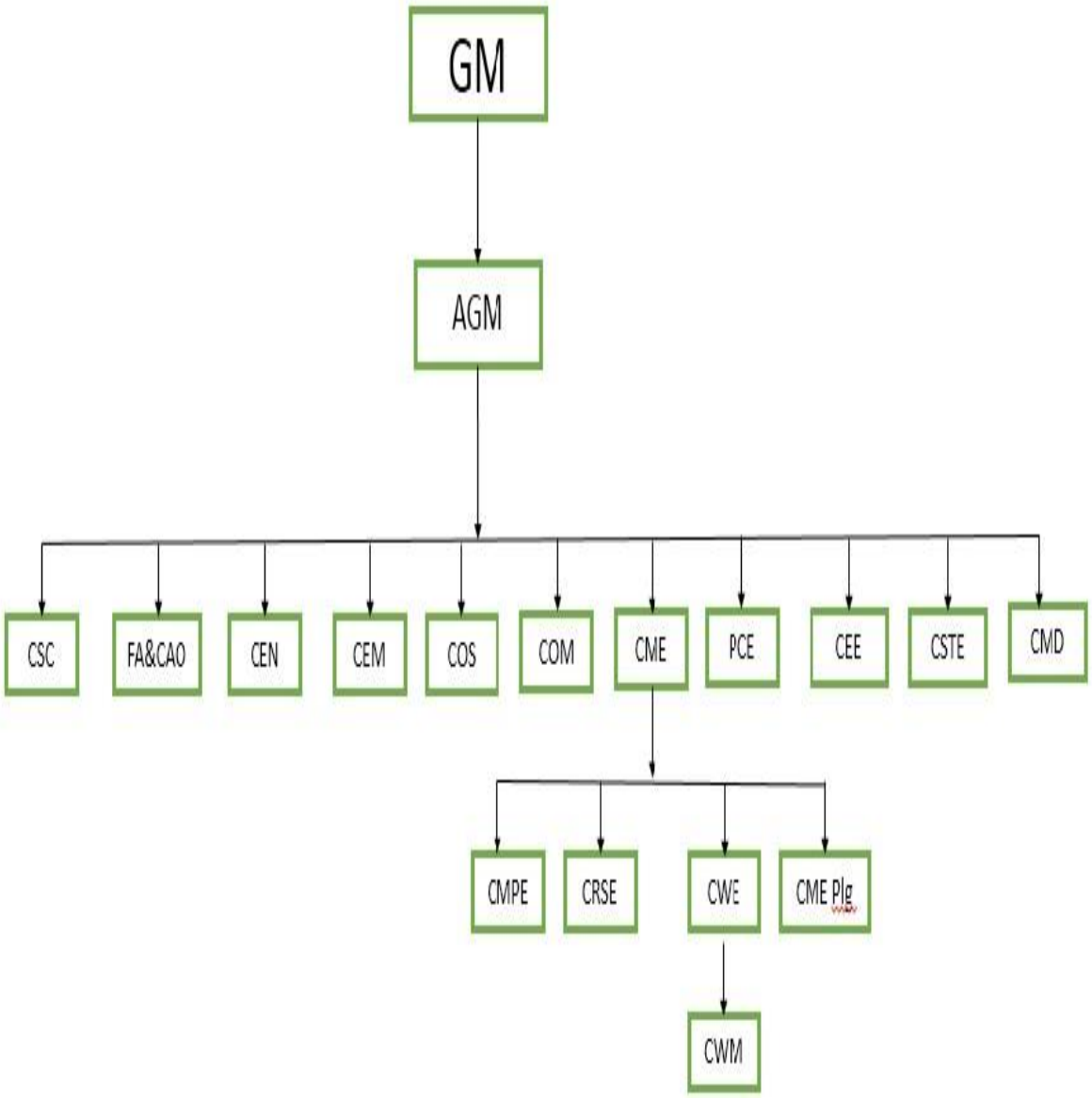
Railway Zones:

Indian Railways is geographically organized into zones. At present there are 17 Zonal Railways (including Metro Railway, Kolkata).

S. No.	Zones	Route Km	Headquarters	Divisions
1	Central (CR)	3905	Mumbai	Mumbai, Bhusawal, Pune, Solapur, Nagpur
2	East Central(ECR)	3628	Hajipur	Danapur, Dhanbad, Mughalsarai, Samastipur, Sonpur
3	East Coast (ECoR)	2572	Bhubaneswar	Khurda Road, Sambalpur, Visakhapatnam
4	Eastern (ER)	2414	Kolkata	Howrah, Sealdah, Asansol, Malda
5	North Central(NCR)	3151	Allahabad	Allahabad, Agra, Jhansi
6	North Eastern (NER)	3667	Gorakhpur	Izzatnagar, Lucknow, Varanasi
7	North Western (NWR)	5459	Jaipur	Jaipur, Ajmer, Bikaner, Jodhpur
8	Northeast Frontier (NFR)	3907	Guwahati	Alipurduar, Katihar, Rangia, Lumding, Tinsukia
9	Northern (NR)	6968	Delhi	Delhi, Ambala, Firozpur, Lucknow, Moradabad
10	South Central (SCR)	5803	Secunderabad	Secunderabad, Hyderabad, Guntakal, Guntur, Nanded, Vijayawada
11	South East Central (SECR)	2447	Bilaspur	Bilaspur, Raipur, Nagpur
12	South Eastern (SER)	2631	Kolkata	Adra, Chakradharpur, Kharagpur, Ranchi
13	South Western (SWR)	3177	Hubli	Hubli, Bangalore, Mysore
14	Southern (SR)	5098	Chennai	Chennai, Tiruchirappalli, Madurai, Palakkad, Salem, Trivandrum
15	West Central (WCR)	2965	Jabalpur	Jabalpur, Bhopal, Kota
16	Western (WR)	6182	Mumbai	Mumbai Central, Ratlam, Ahmedabad, Rajkot, Bhavnagar, Vadodara
17	Kolkata Metro	24.5	Kolkata	

Each zone is under the control of General Manager (GM) who is responsible for its operation, maintenance and financial position. GM is assisted by an Additional General Manager (AGM) and Heads of Department (HoD) for various Departments viz, Transportation, Commercial, Accounts, Personnel, Civil Engineering, Mechanical Engineering, Electrical Engineering, Signal & Telecommunications, Stores, Medical and Security. In departments where more than one HoD is provided one of the HODs is nominated as co-ordinating HoD. For example in Transportation, there are many HOD like Chief Freight Traffic Manager(CFTM), Chief Passenger Traffic Manager(CPTM) etc., but COM is nominated as co-ordinating HoD.

Zonal Organization:



Divisions/Workshops:

Each zone is further classified into Divisions geographically. Divisions are the basic unit of operation. Division is headed by a Divisional Railway Manager who is in the rank of a HoD. At present there 68 Divisions in Indian Railways.

A Railway Division is the smallest administrative Unit of Railways.

Workshops:

The workshop undertakes the periodic overhauling of passenger main line coaches. It also manufactures wheel sets for the workshop as well as various Locomotives.

Workshops are undertaking the following major activities in carriage maintenance.

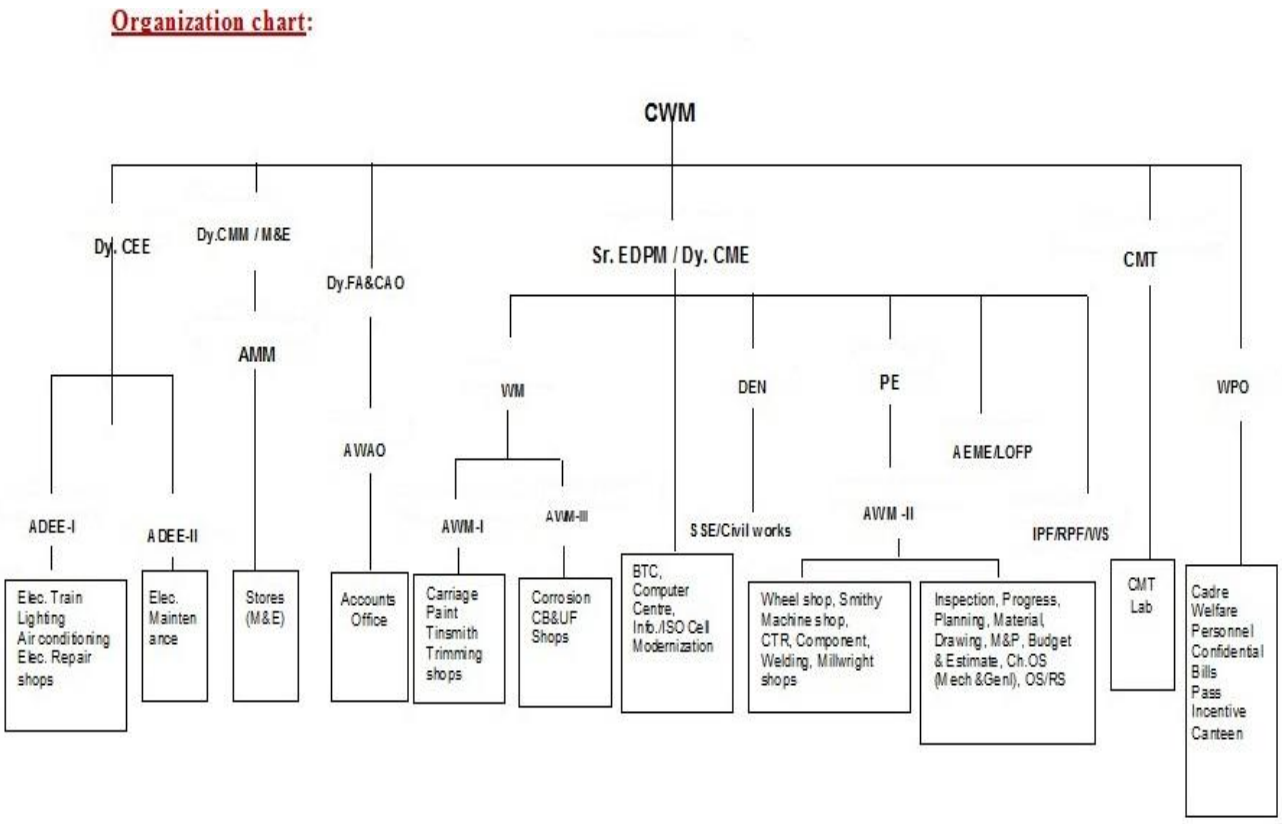
- Overhauling of BG AC and Non AC coaches,
- Refurbishing of interior furnishing under midlife rehabilitation,
- Conversion and construction of ART coaches,
- Rehabilitation of in-service MG coaches for exports etc.
- Furnishing of inspection cars
- Retro fitment of stainless steel trough floor
- Refurbishing of toilet
- Implementation of POH periodicity from 12 months to 18 months

Organization Structure:

Function & Role:

Carriage Repair Workshop, Lallaguda is primarily responsible for periodical overhauling of Rolling Stock (Coaches, DHMUs, DEMUs& MMTS). The stock is attended for overhauling as per the schedule and given fit for traffic.

Organisation Chart :



The workshop is headed by the Chief Workshop manager. There are five departments dealing with various activities such as Mechanical, Electrical, Materials Management, Finance & Accounts, HRD, Audit & Security.

Chief Workshop Manager:

He is overall in charge of Carriage Repair Workshop and assisted by various officers in discharging his duties. Under CWM various departments like Mechanical, Electrical, Accounts, Stores, Chemist & Metallurgy. Each department is headed by concerned departmental head.

Dy. Chief Mechanical Engineer:

He is overall in charge of cadre control, Computer Centre & Training Centre. He is responsible for monitoring Workshop Modernization, Quality Management System, Budget, and assists CWM in all workshop matters.

Dy. Chief Electrical Engineer:

He is responsible for POH of all Rolling Stock pertaining to Electrical wing and maintenance of electrical infrastructure of workshop. He assists CWM in all matters of Electrical department. He is assisted by Jr. Scale officer who looks after Electrical Infrastructure Maintenance and another Jr. Scale officer who looks after rolling stock maintenance.

Dy. Financial Adviser & Chief Accounts Officer:

He is responsible for all activities pertaining to financial matters. He assists CWM in respect of all financial matters. He is responsible for control of budget and exchequer. He is assisted by Jr. Scale officer.

Works Manager – 1:

He is responsible for POH & special repair attention to coaching stock and special stocks like, DHMU, DEMU etc. as per target set by Board. Responsible for outturn of Bogie, Lift Lower, Corrosion, Carriage, Trimming, Tinsmith, Air Brake and Paint shops. He is assisted by AWM-I & AWM-III.

Production Engineer:

He is in charge for production shops namely wheel, component, CTR, Millwright, Machine, Gas & welding shops. He is also responsible for monitoring industrial safety. He is also in charge for Production Control Organization consisting of Inspection, Planning, Progress and Drawing office. Monitoring of incentive system, processing of work orders, Millwright and material planning, commissioning and maintenance, maintenance of all machinery and plant, material plan of all non-stock, AAC revision. He is also responsible for outturn of special stocks like DEMU, DHMU & Tower Cars etc. He is assisted by AWM-II.

Chief Metallurgist:

He is directly responsible for Chemical & Metallurgical investigation of material, failure analysis, NDT etc. Responsible for planning of Pollution Control and waste management inside the workshop.

Workshop Personnel Officer:

He is responsible for HRD activities like Payroll preparation, maintenance of staff needs and maintenance of industrial relation.

LESSON NO. 2
FUNCTIONS OF EACH DEPARTMENT IN SHORT

S. No	Name of Department	Headed by	Role and function
1	Engineering Department	Senior Divisional Engineer	Maintenance of all fixed assets of the Division, i.e. Track, Bridges, Buildings, Roads, Water supply etc.
2	Mechanical Engineering & Power (Transportation) Department	Senior Divisional Mechanical Engineer	Maintenance of all rolling stock of the@ Division (except electric locos and EMU/MEMUs), i.e. locomotives, passenger and freight cars; and technical super etc.
3	Electrical Engineering Department	Senior Divisional Electrical Engineer	Maintenance of all electric locomotives, EMUs/MEMUs and fixed electrical assets of the Division, i.e. Overhead equipment, lighting and power for railway establishments etc.
4	Signal & Telecommunication Engineering Department	Senior Divisional Signal & Telecommunication Engineer	Management of the Signaling and Telecommunication (S&T) infrastructure of the division for Safe Train operations;
5	Operating and Traffic (Transportation) Department	Senior Divisional Operations Manager	Train operations
6	Commercial Department	Senior Divisional Commercial Manager	Passenger ticketing, ticket checking, booking of freight rakes and collecting fares
7	Medical Department	Chief Medical Superintendent	Providing medical facilities to railway employees and their families

8	Safety Department	Senior Divisional Safety Officer	Ensuring safety of train operations
9	Stores Department	Senior Divisional Controller of Stores	Ensuring material for maintenance of trains (material for all departments except the Engineering Department)
10	Accounts Department	Senior Divisional Accounts Officer	Financial management of the division
11	Personnel Department	Senior Divisional Personnel Officer	HR functions
12	Security Department	Senior Divisional Security Commissioner	Security of railway material, passenger and passenger belongings

LESSON NO. 3
LAYOUT OF WORKSHOP WITH IMPORTANT FACILITIES FOR EACH SHOP FUNCTIONS

POH of coaches requires a large no. of activities at different locations of the workshop. This necessitates free flow of man, machine and material, good layout is conductive for that and incorrect layout will result in idle movement of the resources, wastage of man-hours and ultimately drop in quality and productivity.

While drawing out the shop layout, sequence of operations/activities of POH should be kept in mind. The major activities of POH are summarized as under **:**

Code	**Activity**
A	Verification of Deficiencies
B	Pre-inspection and lifting
C	Stripping
D	Body Repair, Modification and Alteration
E	Painting
F	Fitting of water tank, plumbing and leakage testing
G	Repairs to interior panels
H	Fitment of shutters
I	Fitment of Doors
J	Fitment of Berths and Seats
K	Vacuum/Air Brake testing and final works
L	Final Inspection and Dispatch
M	Fitment of Axle pulley, tension rod and testing of coach wiring
N	Testing of Branch wiring and fitment of electrical equipment

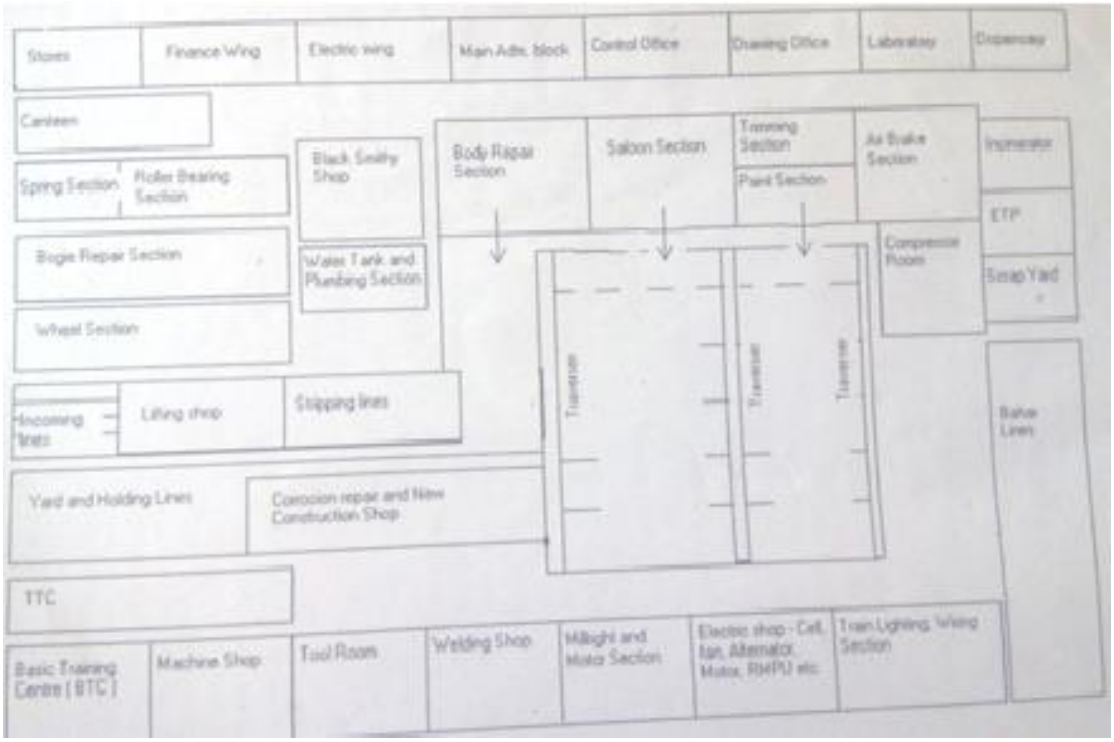
Normal POH time for coach is 18 days. The flow of coaches should be unidirectional and every line should not have more than four coaches keeping in view the above requirements rail lines for each activitycenter are calculated as under **:**

Coaches per Month = 150
Future growth and Bunching allowance @ 10 % =15
Workable coach holding = 165
Average working days/month = 24
Average out turn per day =165/24 = 6.9 say 7

Activity code (a)	Duration (in days) (b)	Coach holding of Activity center ©=7 x b	Coach/line (d)	No. of Lines required (e)=c/d
A	1	1 x 7 =7	4	1.75=2
B	1	1 x 7 =7	4	1.75=2 (1 Normal+ 1 Pitline)
C	2	2 x 7 =14	4	3.5=4 Pitlines
D	3	3 X 7=21	4	5.25=6
E	0.9	9 X 7=63	6	10.5=11 +2 (Free lines for shunting) (3 pitlines 8 Normal lines)
F				
G				
H				
I				
J				
N				
K	1	1 x 7 =7	4	1.75=2(Pitline)
M				
L	1	1 x 7 =7	4	1.75=2(Pitline)
Misc	_	24(Assumption)	8	3 Normal lines

Facilities Required:

- No. of Lines calculated above.
- Covered Accommodation all shops excluding yard and traverse area
- Lighting- The lighting should sufficient. The overhead, side pit and trolley mounted lights should be provided.
- Flooring-The entire covered area and pathway should be paved with min. 150 mm thick reinforced concrete or hardonite flooring.
- Workbenches and Office Accommodations-Double story buildings are preferable
- Communication facilities
- Statutory Requirements
- Material Handling Facilities- Trucks, Leisters, Fork lifters etc. road connectivity is must.
- Machinery and Plants-Grinder, Double spindle drilling machines, pipe threading machines, power hack saw, track surface traverser, EOT cranes etc. Test benches like water tank test rig, DA valve test bench, DV test bench, SCTR et



LESSON NO. 4
ROLE OF WORKSHOP, DIFFERENT SHOPS & ITS FUNCTIONS IN BREIF

Role of Workshops:

- Should tackle all rolling stock maintenance schedules
- Should be a provider of quality spares and should be able to deliver on time
- Should create a system of zero defects and zero deficiencies on rolling/sub-assemblies and components to alleviate the problems of the open line working.
- Should provide a support structure to assist open line depots.
- Should function as a centre for technical excellence and knowledge dissemination.

Shop	Functions	Facilities
Lift shop	To lift , lower and adjust buffer height of coach	Pit line, level track ,lifting arrangement(2 EOT Cranes of 25 ton capacity or 4 nos of 10ton capacity powered jacks.
Body repairs(corrosion repairs) shop	To carry out corrosion repairs like head stock, sole bar and trough floor renewals.	Lifting facility to keep the coach on trustels .hot phosphate plant Welding plants, Gas cutting equipment, Grinding machines
Bogie shop	To carry out complete overhauling of bogies and its sub assemblies.	Eot cranes, bogie press machine, sand blasting plant
Wheel &roller bearing	Wheel gauging, maintaining wheel profile, re-discing, re-axling RB overhauling in position and in dismounted condition.	RB extractors ,RB cleaning plant axle box cleaning plant ,EOT cranes Wheel press, AJTB(axle journal turning and burnishing machine) wheel lathe, Vertical turret lathe

Carriage furnishing	Carry out floor repairs like sub floor ,pvc, aluminum chequered plate Interior pannel repairs Berth repairs ,window shutter repairs, water supply and lavatory furnishing related works. Providinding curtains in AC coaches	Shop to be provided with ventilation and lighting arrangements. Sufficient power plug points Near the coach to operate portable drills ,power saw etc
Air brake	Strip, Over haul, refit air brake components, repairs to air brake pipe lines and test coach braking.	Air compressor, test benches for sub assemblies like DV, Brake Cylinders, cut off angle cocks, AR, PEASD, air hoses Pipe cutting and bending machines, Single car test rig
Draw and buffing Gear	Strip, overhaul and fit Draw and Buffing gear items	Fork lift, Annealing furnace, Tensile testing machine, work benches
Paint shop	Carryout A,C paint schedules	Grit blast plant, paint booth, screen printing equipment.

Production shops :

Shop	functions	facilities
Machine shop	Turning, threading, parting, shaping, milling , drilling & grinding jobs	Lathe , shaping, milling, drilling& grinding machines
Millwright	Maintaining all the machinery available in workshops cranes, traversers, compressors trucks , fork lifts, office cars etc	Required spares and tools
Component shop	Fabrication of coach body items like sole bars, trough sheets, pressed channels and angular, footsteps Battery box frames	Shearing and bending machines, welding and gas cutting equipment.
Welding shop	To cater welding requirements of all shops, procurement of welding and gas plants spares for maintaining the same	Welding and gas cutting plants other equipment like Profile cutting machines, CO2 Welding plants and plasma cutting machines.

LESSON NO. 5

ROLE OF SUPERVISORS IN WORKSHOP AND THEIR RESPONSIBILITIES

INTRODUCTION:

Supervisor means, foreman, foreperson, boss, overseer, cell coach, facilitator, monitor or area coordinator, is the job title of a low level management position that is primarily based on authority over a worker or charge of a workplace. A Supervisor can also be one of the most senior in the staff at the place of work. Supervision, on the other hand, can be performed by people without this formal title, for example by parents. The term Supervisor itself can be used to refer to any personnel who have this task as part of their job description.

An employee is a supervisor if he has the power and authority to do the following actions:

- Give instructions and/or orders to subordinates.
- Be held responsible for the work and actions of other employees.

If an employee cannot do the above, legally, he or she is probably not a supervisor, but in some other category, such as lead hand.

A supervisor is first and foremost an overseer whose main responsibility is to ensure that a group of subordinates get out the assigned amount of production, when they are supposed to do it and within acceptable levels of quality, costs and safety.

A supervisor is responsible for the productivity and actions of a small group of employees. The supervisor has several manager-like roles, responsibilities, and powers. Two of the key differences between a supervisor and a manager are (1) the supervisor does not typically have "hire and fire" authority, and (2) the supervisor does not have budget authority.

Supervisor may not recruit the employees working in the supervisor's group nor does the supervisor have the authority to terminate an employee. The supervisor may participate in the hiring process as part of interviewing and assessing candidates, but the actual hiring authority rests in the hands of a Human Resource Manager. The supervisor may recommend to management that a particular employee be terminated

and the supervisor may be the one who documents the behaviors leading to the recommendation but the actual firing authority rests in the hands of a manager.

There are in general three levels of management in organization. These are top management, middle management, and lower level / front line/ supervisory management. Top management makes policy, middle management broadly interprets policy, while supervisory management's role is restricted to narrow interpretations, which ensure that the day to day running of sections confirms to norms and guidelines laid down by the top management. The supervisor stands at the point where the plans policies of top management are turned into practical results through the efforts of men at work.

Therefore, supervisor is the key front – line manager, the person who can make or break top management plans. In other words, in an organization compared to an arch, the supervisor is a keystone uniting the higher management with the operating employees or workers.

Role of Supervisor:

Super is the person selected by management to take charge of group of people or a special task to ensure that work is carried out satisfactorily.

- Establishes the climate of human relationship at departmental level of the organization.
- Communicates policy directives of top management of operative employees.
- Shapes the Attitude that motivate employees toward better performance.
- Provides on-the-spot guidance and assistance to operating / subordinate staff in attending to certain difficult and ticklish problems and suggest various alternatives to solve the problem.
- Interprets and applies organization policies, work specifications and job orders.
- Initiates or recommends personal actions such as recruitment, promotions, transfers, etc.,
- Plans and maintains time and work schedules.
- Takes necessary steps to secure good quality of output.
- Coordinates the activities of his department in such a way as to meet its goals economically.
- Ensures effective feedback pertaining problems/ issues to top management etc.,

Even though a supervisor plays vital role in an organization the recognition and acceptance of the supervisor by top management only help him to emerge finally as an essential and integrated member of the management group. Unfortunately many

managers do not fully understand the supervisor s role, consequently, a large number of problems and issues have crept into supervisory management and the present supervisors status in shaky and insecure.

The supervisor must track each employee on a frequent basis to ensure optimal levels of productivity. If an employee isn't living up to their potential on the job, the supervisor must speak to this employee to make sure that the employee improves their work performance. If not, the supervisor may be responsible for beginning the firing process.

Beyond that, the supervisor may have to oversee teams of employees according to the Office of Personnel Management or OPM. If these teams need assistance finishing a project, the supervisor should be around to help them and to boost morale to get the job done. The rest of the team may look to the supervisor to take over leadership for the project.

When it comes to the safety of the employees and the workplace, the supervisor also has a role. The supervisor must make sure that the workplace maintains all safety precautions so that employees can focus on work. A supervisor must also keep their eyes open for any type of sexual harassment, abuse or any other issues in this vein that could threaten an employee's career. In these situations, the supervisor must step in to make sure that the workplace remains an equal space for everyone.

Duties and Responsibility of Supervisor **:**

- Witness GA card attendance of staff.

- Marking physical attendance in the register.
- Issue of absent memo at 07.40Hrs and at 08.10HRs allowing 30 min for late attendance.
- Distribution of work to staff and record the same in the job distribution register.
- Arrangement of material, tools and plants for the job.
- Instruct the staff to carry out the work as per work instruction and following safety precautions.
- Drawing of material from store / sub store.
- Placing work orders which can be manufactured within the shops.
- Issuing the memo to progress per placement of coaches for convenient location to carry out the work.
- Monitoring the material moment new and released .
- Maintaining register, records for accountable material stock / non stock.
- Maintaining the record , ISO related.
- Monitoring the progress of work.

- Inspection of coaches for assessment of work involved as per inspection sheet.
- Communication with other sections about the completion of work to allow them to work further.
- Offering the coach to NTXR for pre inspection and final inspection.
- Maintaining the record pro-forma for testing / inspection.
- Maintaining tools and plants in proper working condition with the help of millwright staff.
- Issuing breakdown memo to millwright shop in case of breakdown of M&P.
- Recommending the leave of staff duly entering in the leave register.
- Referring to the relevant drawings in case of modification, alteration and special work.
- Accessing the material requirement in advance for the RSP workers, modification and conversion work.
- Ensuring the safety of the staff by giving safety instruction time to time.
- Maintaining the shop floor housekeeping and cleaning.
- Periodical surprise checks to ensure the availability of staff at work spot.
- Issue the absent memo for those who are absconding.
- Maintaining the discipline and punctuality among the staff.
- Encourage the staff by recommending the names for awards, like Man of the month, railway week awards.
- Initiating the disciplinary action for bad times keeper, bad performers and for failures of coaches.
- Informing the SSE concerned about targets achieved, modification/ conversation completed during the months, during years.
- Initiate the condemning process for over aged M&P.
- Updating his skills by attending nominated training courses, referring latest instruction, CIAs and TSOs etc.
- Arrange the infrastructure required fixed/ movable for the staff to carry out the work efficiently and safely
- Initiating and implementing the latest techniques and tools for reducing human effort at the same time improving the reliability of the system.
- Development of special tools and gadgets for easiness of work and manpower economy.

LESSON NO. 6

MATERIAL HANDLINGS METHODS AND EQUIPMENTS

A material handling for long has been considered as an activity of lifting, shifting and placing of any material regardless of size, form and weight. However, with the growing complexities of the production operations, a need has been felt to integrate the materials handling function with the production operation and control production control functions. The function of production control in any enterprise is to optimise the production within the limitations imposed by manufacturing and marketing conditions. It determines factors like what is to be done, where it is to be done, how it is to be done and when it is to be done. Whereas materials which are to be moved as per the schedules of manufacturing and production control. The procedures, actions and evaluations used in controlling the movement of materials create a strong link between the functions of materials handling, production operations and production control. Realisation of this integrated systems approach offers a great opportunity for the reduction in production delays and costs in the industry. Materials Handling is, therefore, now being considered as Preparation, Placing and Positioning of materials to facilitate their movement or storage. It relates to every aspect of product except the actual processing".

Definition of Material Handling :

The American Society of Mechanical Engineers (ASME) has approved the following definition: "Materials Handling is the art and science involving the moving, packaging and storing of substance in any form." A few other representative definitions mentioned elsewhere are:

- Materials handling is the creation of time and place utility in a material.
- Materials handling IS the lifting, shifting and placing of materials, which effect savings in money time and place.

Materials Movement Management :

The growing complexities of the production processes, the increasing competitive practices within the industry and in the country, coupled with the rising cost of labour has led to increased awareness in managers and engineers about the application of materials handling techniques to cut down the unit cost of production and to increase the productivity in the enterprises. There are a number of success stories, but the

desired situation is yet to be obtained. It can be inferred that past approaches to materials handling have frequently led to lessening the magnitude of the problem rather than completely solving the same. Even now idle lying handling equipments or machines waiting for handling equipments are very common sight in our industries, especially in engineering and construction units. This can possibly be attributed to the fact that the approach to materials handling, though sometimes claimed to be systems oriented, has mostly been fragmented are ultimately, equipment-oriented.

Growing number of materials handling equipment manufacturers in India, easy availability of the equipment, flexibility in usage, and intensive sales campaign have resulted in the undesirable tendency to confuse the materials handling system with the use of mechanical aids to the handling. Of course, in many a situation the mechanisation can be useful and increase the efficiency of the system but a quick jumping in this direction takes away the opportunity for a logical and a procedural analysis. The central point of focus then becomes, "How to handle" which leads to "What type of equipment should be used" and this often, results in purchase of some adhoc equipment which suits the budget only or is being used in similar conditions elsewhere. Whereas the concern should be on "Systematic Movement Analysis" and "Management Requirement Analysis" wherein "Handling Analysis" forms only a part of the exercise.

"Materials Movement Management" thus, is a broader concept covering the analysis, integration, coordination of Production Management System, Materials Management, Materials Handling, Facility Planning and Plant Engineering into an interlinked framework with a view to achieving optimum cost of movement and storage of materials to meet the production and delivery schedules of the company."

The approach based on Materials Movement Management focuses attention on the four aspects viz. material, moves, methods and management. The basic analysis should therefore, be as follows:

- METHOD
- MATERIAL
- MOVES

What materials are to be moved and why?

Where and when the materials are to be moved and why?

How the material is to be moved.

Management:

What is the cost of movement?

What are the Systems implications?
What is the efficiency of the system?

Material Handling Principles:

Some of the major principles in the design of an efficient system of materials handling are:

Reduce handling to a minimum:

As far as possible materials should always move towards completion, over, the shortest distance without back-tracking. Often materials move back and forth over large distances unnecessarily. A large amount of handling can be eliminated by planning the location of operations so that one operation finishes right where the next begins. The flow of product should receive top priority in planning of layout.

Avoid re-handling:

It may not be possible to eliminate re-handling completely, nevertheless re-handling is a wasteful and costly operation. Re-handling can be reduced by (i) not keeping anything on floor, (ii) avoiding transfers from floor to container or vice versa or from container to container and (iii) avoiding mixing of materials.

Combine handling with other operations:

Many times handling may be, made a productive activity by combining with other operations, such as production, inspection, and storage. In process industries, materials undergo physical and chemical changes while in movement, handling devices may be used as live storages or materials may be sorted and inspected while they are being handled.

Ensure safety in handling:

Safety is a key word in handling. A large percentage of industrial accidents are attributed to poor handling practices. Even more costly in terms of money in the damage to equipment and products due to improper handling methods. A good handling system should ensure safety to walkers and materials. Manual handling of heavy objects materials scattered on floor or projecting into aisles are but a few causes of accidents. Keeping gangways and aisles clear is one of the primary precautions against accidents in handling.

Handle materials in unit loads:

It is easier and quicker to move a number of materials at a unit rather than piece by piece. Modern material handling devices are designed to take advantage of unutilized loads.

Use gravity where possible and mechanical means if necessary. The simplest and cheapest way to handle materials is by using gravity.

Often chutes and inclined boards can conveniently used to transport materials quickly to the point of use about much investment on costly handling equipment. Where it is not possible to use gravity for various practical reasons, some mechanical means should be considered. Lifting and carrying of heavy materials mechanical1y saves time and reduces fatigue of workers.

Select proper handling equipment:

There are as many types of handling equipment available today as the number of materials to be handled. And any single equipment may not solve all handling problems. It is therefore, necessary to choose the equipment suitable for the job under consideration. The equipment selection needs to be done carefully so that there is an efficient coordination of all handling, resulting in overal1 economy. Use of standardized equipment facilitates maintenance and repair.

Another important factor in the selection of equipment is flexibility.

Industrial activity is subject to constant changes and handling equipment should provide for this change. In other words, the equipment selected. should be capable of a variety of uses and applications.

Reduce terminal time of equipment:

The advantage of mechanical and power equipment would be lost if they are made to wait during loading and unloading this may take considerable amount of time. By reducing this waiting time the handling equipment could be released for more productive work. There are various mechanical devices like trailers; tipping arrangements, cranes and hoist attachments, to quicken loading and unloading operations.

Buy equipment for overall savings:

In selecting equipment savings in overall handling cost must be the guiding principle rather than the first costs of equipment. Arriving at handling costs is a difficult problem but a fairly accurate estimate can be obtained by determining the handling elements and applying work measurement.

In India labour is still comparatively less costly and a longer period may have to be allowed for amortizing the handling equipment. All direct and indirect savings are to be taken into consideration while deciding on handling equipment.

Use labor consistent with handling methods:

Manual handling could be done by unskilled labour, whereas mechanical handling may. Require semi-skilled or skilled workers. Proper allocation of skills helps in overall economy. As far as possible direct production operators should not be used for handling operations. It is preferable to have a separate gang of material handlers to ensure proper utilization of production workers.

Train workers and maintain equipment:

Careful operation and proper upkeep are essential for getting the maximum out of the handling equipment. Careful selection and training of employees in principles, operation and safety rules and planned maintenance of equipment are 'worthwhile investments in the long run.

Efficient Material Handling:

Use of right method to provide right amount of right material at the right time in the right sequence, right position, right condition and at right cost.

Types of Material Handling Equipment:

The material handling equipments are classified under 5 categories.

Conveyors:

Used to move the material between two fixed stations either continuously or intermittently.

- Roller Type
- Wheel Type
- Bucket Type
- Screw Type

Industrial Trucks And Trolleys :

Moving materials in a shop floor in a flexible manner.

- Trollies
- Motor Trucks
- Fork Lifts
- Platform Truck

Cranes and Hoists :

Moving the material on over head space without disturbing workers.

Examples : - Jib cranes, Bridge cranes, Circular cranes

Hoists : Chain hoists, Electric hoists, Pneumatic hoists

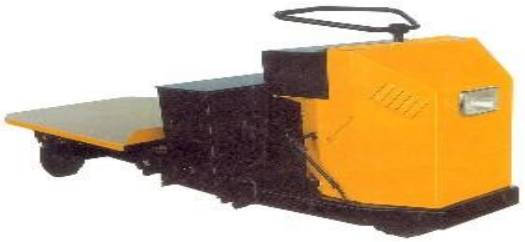
Containers :

- Dead Container : Contains material but not moved.
- Live Container : Contains material and can be moved.

E.g. Power trucks, wagons etc.

Robot:

Performs the operation and also move material from one place to another for material handlings. It can also perform the operation where men cannot perform the job due to hostile conditions.



LESSON NO.7
MACHINERY AND PLANT MAINTENANCE

What is Maintenance:

- The activity carried out to prevent the occurrence of failure
- The activity carried out after failure to rectify the defect is called maintenance.

Why Maintenance Required?

- Plant and Machines in any organization expected to run continuously without any interruption during the production period.
- Interruptions are frequently felt on account of machine break downs due to failures of machine parts / components.
- There is always some loss of production on account of machine failure.

Objective of Maintenance:

- The primary objective of maintenance is to increase the operational reliability and personnel safety at minimum cost.
- Failures are inevitable due to natural wear and tear.

Production Vs Maintenance:

- The total production that can be obtained from a plant depends upon its capacity and the number of working hours.
- Interruptions on account of break down reduce the total time available for production. Therefore
- Production = Capacity x Availability

Down Time:

- The duration by which any machine goes out of production due to break down is called down time.
- The down time is the total time taken on account of maintenance to rectify the failure.
- The total time taken on account of maintenance involves the time actually spent by the respective maintenance team to correct the fault and waiting time for want of spares required for rectify the defect.
- Down time = Repair time + Waiting time

Waiting time :

- The waiting time is the most unproductive elements of total down time. The reason for waiting time could be:
- Want of spares

- Want of crew members
- Lack of communication
- Lack of proper supervision

Role of Maintenance :

- Maintenance play an important role in a manufacturing activity where plants and machineries are employed.
- No machine can work indefinitely and produce continuously.
- There is going to be some interruptions in production due to machine failures. At the same time higher the number of failures greater will be the loss of availability and production. The frequent failures cause frequent interruption in the production and the plant and machines become unreliable.

- This degree of uncertainty in production due to machines failures is termed as reliability.
- Higher the reliability in operation lesser will be the failure or vice versa.

Mean Time Between Failure (MTBF) :

- This is the average time a machine can operate without the occurrence of any failure.
- MTBF indicates the operational reliability of the machine. Higher the value of MTBF, higher will be the operational reliability of the machine because of lesser number of failures.
- Mean Time Between Failure (MTBF) To improve the operational reliability, the number of failures should be reduced. Failures can be reduced if the machines are maintained properly with adequate care and attention.
- Failures can reduce by better maintenance.

Need of Maintenance :

Need of maintenance arise for two reasons.

- To prevent the occurrence of any possible failures.
- To correct a failures in a shortest possible time.

Poor maintenance :

Causes economic losses such as

- Increased down time
- Poor efficiency
- Deterioration of equipment
- Poor quality of product
- Higher labour costs

- Loss of material in process
- Higher production costs
- Increased hazards etc.

Systematic maintenance :
Results to saving in money, material and man power. These savings come through,

- Reduction in down time
- Reduced losses of material in process
- Increased life of the equipment
- Reduction in over time
- Optimum spares inventory
- Timely replacement of spares and machines
- Maintenance of product quality
- Proper running of the equipment

Type of Maintenance :
There is two type of maintenance

- Preventive maintenance
- Breakdown maintenance

Breakdown Maintenance :

- The activity which is carried out after the occurrence of failure to correct the failure is known as break down / corrective maintenance.

Disadvantages:

- There is always an urgency to put the machine back in the working condition and hence the machine may not get adequate maintenance.
- Since the type and time of breakdown is uncertain, production plans get completely disrupted.
- Planning of maintenance work is not possible
- Distribution of work load is difficult
- Results imbalanced utilization of maintenance staff

Breakdown Maintenance :

- Increased overtime
- Increased down time of equipment due to non availability of man power
- Excessive inventory of spares
- Waste of materials in process in continuous chemical industries
- Poor working conditions for maintenance staff

This system is suitable in certain conditions like:

- Where capacity exceeds market demand
- Standbys are available and quick switching over is possible
- Economical for non critical M & P where this type of maintenance is cheaper than any other system

Preventive Maintenance :

- The activity which is carried out to prevent the occurrence of failure is known as preventive maintenance.

Elements of Preventive maintenance system :

- An inventory of all M & P that need to be maintained
- Categorization of equipments to assess the relative importance and thereby determine the equipments requiring preventive maintenance.
- A well designed inspection system
- A good lubrication system
- Maintenance of adequate records and analysis of these records
- Planning of maintenance work
- Control of maintenance stores and spares
- Organization for preventive maintenance work.

Preventive Maintenance :

- Preventive maintenance is planned maintenance of M & P that is designed to improve equipment life and avoid any unplanned maintenance activity.
- Periodical inspection of M & P to discover conditions of deterioration
- Up-keep of equipment to remove or repair such conditions is a well planned inspection system.
- Proper inspection at the right time is the crux of the preventive maintenance system.
- The results of inspection are used to analyze the problems of upkeep, replacement and modification well in advance and thereby help proper planning and assessment of the work contents of the jobs.

Direct Preventive Maintenance :

- Direct preventive maintenance activities are such as cleaning, lubricating, replacement of wear / tear parts and overhauling of machine.
- Most of the common failures which are likely to occur during running of machinery can be arrested.
- This cannot give 100% operational reliability. Because there is always chances of unexpected failures to occur.

Preventive Maintenance :
Preventive maintenance is further divided in two parts.

- Direct maintenance
- Indirect maintenance

Indirect Preventive Maintenance Condition Monitoring :

- By constantly monitoring the observable characteristics any major faults / failures that is being gradually developed can be detected before hand.
- This constant monitoring of observable characteristics and measurable parameters in any plant and machinery is called " Condition Monitoring"
- Indirect preventive maintenance helps to take corrective action in planned manner by giving the reports as and when parameters changes sharply.

Categorization of M & P :

- Critical Machines
- Semi-Critical Machines
- Non-Critical Machines

Critical Machines :

- These machines require rigid operating instructions,
- Inspection schedule and procedures,
- Cleaning schedules and controlled lubrication.
- Most of the effect of preventive maintenance department should be on these machines and down time should be strictly controlled.

Semi- Critical Machines :

- These machines require operating instructions
- Inspection
- Cleaning
- Lubricating schedules
- Breakdowns should be reduced

Non-Critical Machines :

- These machines are not an important.
- These machines require operating instructions
- Cleaning and
- Lubrication schedules
- These machines can be attended after
- Breakdown.

Categorization of M & P in view of PM :

- Before chalking out an elaborate preventive maintenance
- programme
- Administration will have to make a careful analysis as to which type of equipment need preventive maintenance.
- It may not be economical to have PM for each and every sundry machine.
- Even if it is desirable to have preventive maintenance on all M & P, for initial introduction of the system priorities will have to be decided, as the company might like to bring in only the important M & P within the frame work of preventive maintenance.
- There are various other systems of maintenance like scheduled maintenance which may be desirable for certain types of equipment.

Factors that need to be taken into consideration are:

- Factors that need to be taken into consideration are:
- Whether the M & P is continuous or intermittent running.
- An unscheduled or a sudden breakdown of a continuous running machine with a high degree of utilization, will obviously cause considerable production loss.
- In the event of failure of a particular machine, whether a substitute or a standby is available.
- If there is a standby the same can be switched on without any delay and meanwhile the machine can be repaired and put in condition.
- How important is the machine from the point of view of the quality of the product that is coming out of the machine. On the other works what could be the loss as a result of poor quality or rejections.
- What is the position with regard to availability of spares, easy or difficult to obtain.
- What is the position with regard to availability of spares, easy or difficult to obtain.
- What are the likely hazards that the equipment can cause on the workers and other employees equipments which have certain inherent hazards need meticulous care.
- Evaluation can be done jointly by the production and maintenance personnel in order to arrive at the overall criticality.
- Machines of similar degree of importance can be grouped together which in turn will help to determine the type of analysis priority for preventive maintenance can be decided.

Preventive Maintenance :

- Preventive Maintenance can be broadly
- divided into:

- Maintenance by the operator and
- Maintenance by Preventive Maintenance group under the Millwright organization.

Maintenance by the operator :
The operator is required to attend to the following:

- Daily cleaning of machine bed and slide ways and lubrication points and working surfaces. He must check up oil level, start and see oil flow daily before starting work.
- All lubrication points which have to be lubricated by the machine operator may be painted with a distinctive colour for grease lubrication. Such lubrication point which are not be touch by the operator may be marked with a cross.
- The operator should be required to follow the instructions given in the maintenance manual for each machine. The maintenance manual and instruction book should be made available on the shop floor.
- The operator should immediately report his Supervisor, if he considers that there is anything wrong with the machine . The Supervisor should take appropriate steps to bring this to the notice of the Millwright Shop

Maintenance by the Preventive Maintenance Group under the Millwright shop :

- Daily schedule (in the case of vital heavy duty machine)
- Weekly schedule
- Monthly schedule
- Quarterly schedule
- Six monthly schedule
- Annual schedule

Daily schedule:

- Clean, Oil and Grease bearings and slides
- Check all bolts and nuts
- Check and lubricate main / counter shaft bearings
- Check safety devices and overload preventive devices, limit switches, brakes etc.

Weekly Schedule:

- Checkup oil level and top up
- Check up coolant
- Check and adjust glad packing where ever necessary
- Check up relay contactors for motor magnetic clutches

Monthly Schedule:

- Pump and fittings
- Clean filter oil strainer, felt wipers, cover oil pump and taking up slacken wedges and liners
- Check and adjust main clutch, clutch pins, clutch blocks

- Check and adjust self action of slides and turret
- Check up tension and adjust belt
- Grease all points where indicated
- Clean and refill coolant tank
- Check lubricating system and pipes for blocks

Quarterly Schedule:

- Clean and check bearings of headstock and grease
- Check up tool posts and turrets

Six monthly Schedule:

- Lubrication
- Overhaul of lubricating system
- Clean, flush and refill of lubricating points
- Clean, flush and refill feed drive unit
- Inspection
- Check up the gear shafts clutches and brakes, bearings drive gears, shaft bearing, tool posts, turret slide locks, lead screw, lubricating and coolant pumps, pipes and pipe connections, tail stock, slides, slide beads etc.

Annual Schedule:

- Check hydraulic pump / motor alignment
- Check machine level
- Check machine / auto tool changer alignments and slide strakes

Conclusion:

- Preventive maintenance required to keep the machine ready for production with safety.

- The advantages of preventive maintenance are reliability, safety and above all the availability of right machine at all the times.

LESSON NO. 8
JIGS, FIXTURES &GAUGES

Some machining operation are so simple' which are done quite easily, such as turning, the job is held in position in the chuck and turning operation is done easily. No other device is required to hold the job or to guide the tool on the machine in such an operation. But some operations are such type in which the tool is required to be guided by means of another device and also some jobs are of such forms which are required to be held in position on the machine by means of another device. The device which guides the tool is called jig and the device which holds the job in position is called fixture.

Jigs and fixtures are special purpose tool which are used to facilitate production (machining, assembling and inspection operations), when work piece is based on the concept of interchangeability according to which every part will be produced within an established tolerance. Jigs and fixtures provide on means of manufacturing interchangeable parts since they establish a relation with predetermined to tolerance between the work and cutting tool. They eliminate the necessity of a special set up for each individual park. So' A jig is may be de-fined as a device which hold and position the work; locate or guides the outing tool relative to the work piece and usually not fixed to the m/c table. It is usually lightly in construction.

A fixture is a work holding device and position the work; but doesn't guide 'locate or position the cutting tool' the setting of the tool is done by machine adjustment and a setting blocker using slip gauges. A fixture is hold or clamp-ed to the machine table. It is usually heavy in construction. Jigs are used on drilling , reaming , tapping and couter boring operations , while fixtures are used in connection with turning , milling , grinding , shaping , planning and boring operations.

The use of jig and fixture makes possible more rapid and more accurate manufacturing at a reduction of cost.

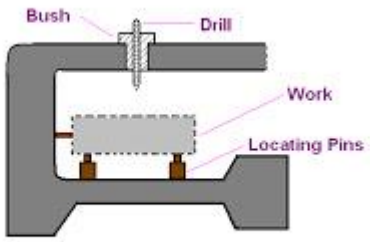
Uses of Jigs and Fixtures:

- Jigs and fixtures are used to reduce the cost of production as there use elimination being out work and setting up of tools.
- To increase the production.
- To assure the high accuracy of the parts.
- To provide for interchangeability.
- To enables heavy and complex shaped parts to be machined by holding rigidly to a machine.
- To control quality control expenses.
- Less skilled labor.

- Saving labor.
- There use partially automates the machine tool.
- Improve the safety at work, thereby lowering the rate of accidents.

Jigs:

The most-common jigs are drill and boring jigs. These tools are fundamentally the same. The difference lies in the size, type, and placement of the drill bushings. Boring jigs usually have larger bushings. These bushings may also have internal oil grooves to keep the boring bar lubricated. Often, boring jigs use more than one bushing to support the boring bar throughout the machining cycle.



-: Jig :-

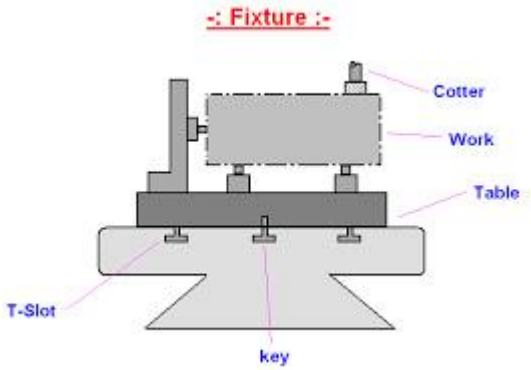
In the shop, drill jigs are the most-widely used form of jig. Drill jigs are used for drilling, tapping, reaming, chamfering, counter boring, countersinking, and similar operations. Occasionally, drill jigs are used to perform assembly work also. In these situations, the bushings guide pins, dowels, or other assembly elements.

Jigs are further identified by their basic construction. The two common forms of jigs are open and closed. Open jigs carry out operations on only one, or sometimes two, sides of a work piece. Closed jigs, on the other hand, operate on two or more sides. The most-common open jigs are template jigs, plate jigs, table jigs, sandwich jigs, and angle plate jigs. Typical examples of closed jigs include box jigs, channel jigs, and leaf jigs. Other forms of jigs rely more on the application of the tool than on their construction for their identity. These include indexing jigs, trunnion jigs, and multi-station jigs.

Specialized industry applications have led to the development of specialized drill jigs. For example, the need to drill precisely located rivet holes in aircraft fuselages and wings led to the design of large jigs, with bushings and liners installed, contoured to the surface of the aircraft. A portable air-feed drill with a bushing attached to its nose is inserted through the liner in the jig and drilling is accomplished in each location.

Fixtures:

Fixtures have a much-wider scope of application than jigs. These workholders are designed for applications where the cutting tools cannot be guided as easily as a drill. With fixtures, an edge finder, center finder, or gage blocks position the cutter. Examples of the more-common fixtures include milling fixtures, lathe fixtures, sawing fixtures, and grinding fixtures. Moreover, a fixture can be used in almost any operation that requires a precise relationship in the position of a tool to a workpiece.



Fixtures are most often identified by the machine tool where they are used. Examples include mill fixtures or lathe fixtures. But the function of the fixture can also identify a fixture type. So can the basic construction of the tool. Thus, although a tool can be called simply a mill fixture, it could also be further defined as a straddle-milling, plate-type mill fixture. Moreover, a lathe fixture could also be defined as a radius-turning, angle-plate lathe fixture. The tool designer usually decides the specific identification of these too

GAUGES:

A gauge in science and engineering, is a device used to make measurements or in order to display certain information, like time. A wide variety of tools exist which serve such functions, ranging from simple pieces of material against which sizes can be measured to complex pieces of machinery. Depending on usage, a gauge can be described as "a device for measuring a physical quantity", for example "to determine thickness, gap in space, diameter of materials, or pressure of flow", or "a device that displays the measurement of a monitored system by the use of a needle or pointer that moves along a calibrated scale.

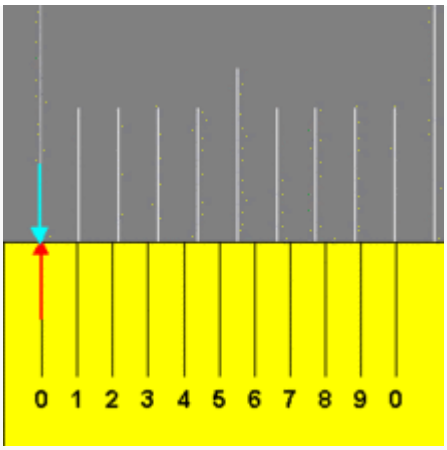
- Vernier calipers.
- Micro metre (screw gauge)
- snap gauge.
- slip gauge.
- Thread plug.
- Thread ring.

- Feeler Gauge.
- surface finish gauge.
- sign bar.

Vernier Calipers:

Construction:

In the following, N is the number of divisions the maker wishes to show at a finer level of measure.



Direct verniers are the most common. The indicating scale is constructed so that when its zero point is coincident with the start of the data scale, its graduations are at a slightly smaller spacing than those on the data scale and so none but the last graduation coincide with any graduations on the data scale. N graduations of the indicating scale cover N−1 graduations of the data scale.

Retrograde verniers are found on some devices, including surveying instruments.[8] A retrograde vernier is similar to the direct vernier, except its graduations are at a slightly larger spacing. N graduations of the indicating scale cover N+1 graduations of the data scale. The retrograde vernier also extends backwards along the data scale.

The main use of the vernier caliper is to measure the internal and the external diameters of an object. To measure using a vernier scale, the user first reads the finely marked "fixed" scale (in the diagram). This measure is typically between two of the scale's smallest graduations. The user then reads the finer vernier scale (see diagram), which measures between the smallest graduations on the fixed scale—providing much greater accuracy.

It is also used in measuring an object to its lowest decimal point.

Least Count of Vernier scale:

Let the measure of the smallest main scale reading, that is the distance between two consecutive graduations (also called its *pitch*) be **S** and the distance between two consecutive Vernier scale graduations be **V** such that the length of **(n-1)** main scale divisions is equal to **n** Vernier scale divisions. Then,
the length of (n-1) main scale divisions = the length of n vernier scale divisions

$$\text{or, } (n-1)S = nV$$

$$\text{or, } nS-S = nV$$

$$\text{or, } S = nS - nV$$

$$\text{or, } S/n = (S-V)$$

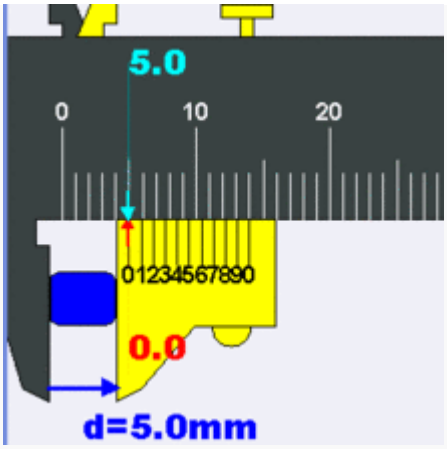
or *(Pitch)/(Number of Vernier scale divisions) = (Length of one main scale division - Length of one Vernier scale division)*

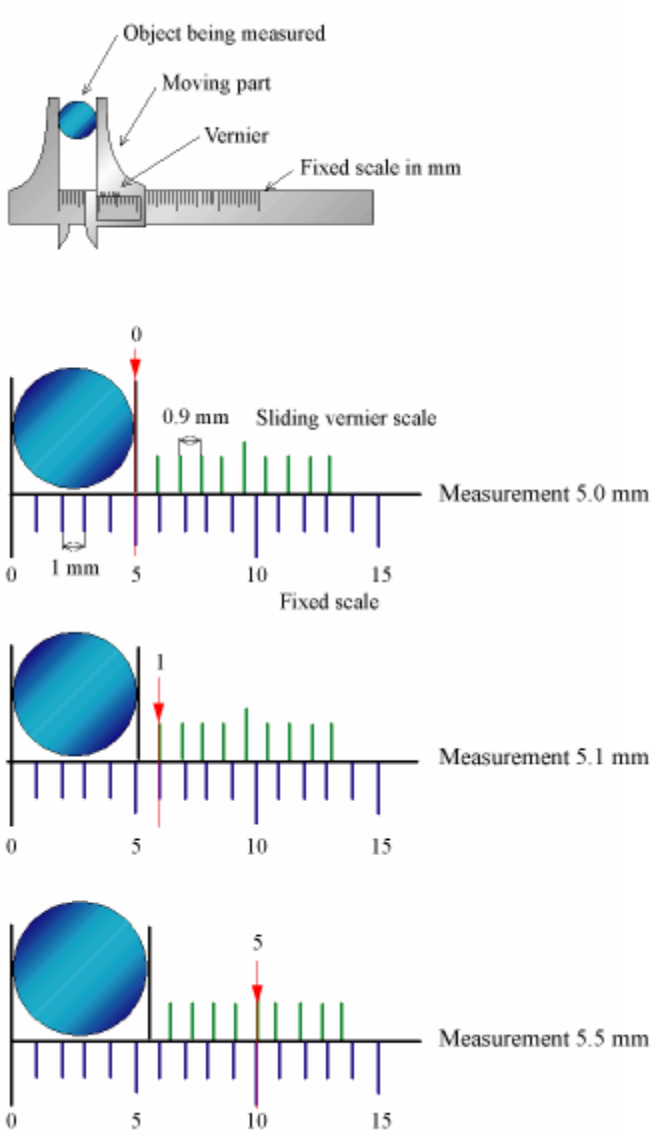
S/n and *(S-V)* are both equal to the least count of Vernier Caliper, and are also termed as ***"Vernier constant"***.

Examples: On decimal measuring instruments, as in the diagram below, the indicating scale has 10 graduations that cover the same length as 9 on the data scale. Note that the vernier's 10th graduation is omitted.

On an angular measurement instrument, the data scale might be in half-degrees, with an indicator scale that provides 30 1-minute graduations (that span 29 of the half-degree graduations).

How a vernier scale works?





The vernier scale is constructed so that it is spaced at a constant fraction of the fixed main scale. So for a decimal measuring device each mark on the vernier is spaced nine tenths of those on the main scale. If you put the two scales together with zero points aligned, the first mark on the vernier scale is one tenth short of the first main scale mark, the second two tenths short, and so on up to the ninth mark—which is misaligned by nine tenths. Only when a full ten marks are counted is there alignment, because the tenth mark is ten tenths—a whole main scale unit short, and therefore aligns with the ninth mark on the main scale.

Now if you move the vernier by a small amount, say, one tenth of its fixed main scale, the only pair of marks that come into alignment are the first pair, since these were the only ones originally misaligned by one tenth. If we move it two tenths, the second pair aligns, since these are the only ones originally misaligned by that amount. If we

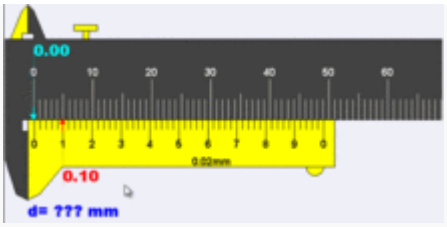
move it five tenths, the fifth pair aligns—and so on. For any movement, only one pair of marks aligns and that pair shows the value between the marks on the fixed scale.

Vernier Acuity:

Vernier scales work so well because most people are especially good at detecting which of the lines is aligned and misaligned,and that ability gets better with practice, in fact far exceeding the optical capability of the eye. This ability to detect alignment is called 'Vernier acuity'. Historically, none of the alternative technologies exploited this or any other hyper acuity, giving the Vernier scale an advantage over its competitors.

Zero error:

Zero error is defined as such a condition when a measuring instrument registers a reading when there should not be any reading. In case of vernier calipers it occurs when a zero on main scale does not coincide with a zero on vernier scale. Rather the zero error may be of two types i.e. when the scale is towards numbers greater than zero it is positive else negative. The method to use a vernier scale or caliper with zero error is to use the formula: actual reading = main scale + vernier scale − (zero error). Zero error may arise due to knocks that cause the calibration at the 0.00 mm when the jaws are perfectly closed or just touching each other.



When the jaws are closed and if the reading is 0.10mm, the zero error is referred to as +0.10mm. The method to use a vernier scale or caliper with zero error is to use the formula 'actual reading = main scale + vernier scale − (zero error)' thus the actual reading is 19.00 + 0.54 − (0.10) = 19.44 mm

Positive zero error refers to the fact that when the jaws of the vernier caliper are just closed, the reading is a positive reading away from the actual reading of 0.00mm. If the reading is 0.10mm, the zero error is referred to as +0.10 mm.

When the jaws are closed and if the reading is −0.08mm, the zero error is referred to as +0.08 mm. The method to use a vernier scale or caliper with zero error is

to use the formula 'actual reading = main scale + vernier scale + (zero error)' thus the actual reading is 19.00 + 0.36 + (+0.08) = 19.44 mm

FORMULA for LEAST COUNT of VERNIER CALIPER = least count of main scale/number of division on vernier scale

Negative zero error refers to the fact that when the jaws of the vernier caliper are just closed, the reading is a negative reading away from the actual reading of 0.00mm. If the reading is 0.08mm, the zero error is referred to as +0.08mm. If positive, the error is subtracted from the mean reading the instrument reads. Thus if the instrument reads 4.39 cm and the error is +0.05,the actual length will be 4.39-0.05=4.34 cm. If negative, the error is added from the mean reading the instrument reads. Thus if the instrument reads 4.39 cm and as above the error is -0.05 cm, the actual length will be 4.39+0.05=4.44 cm. (Considering that, The quantity is called zero correction which should always be added algebraically to the observed reading to the correct value.)

Zero Error (Z.E) = + or- n* Least Count(L.C).

Micrometer:

sometimes known as a micrometer screw gauge, is a device incorporating a calibrated screw widely used for precise measurement of components in machining as well as most mechanical trades, along with other metrological instruments such as dial, vernier, and digital calipers.

Operating principles:

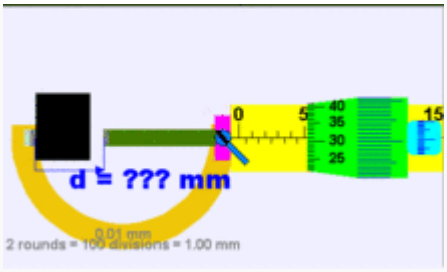


Diagram of a micrometer used to measure an object (black) of length = 4.14 mm

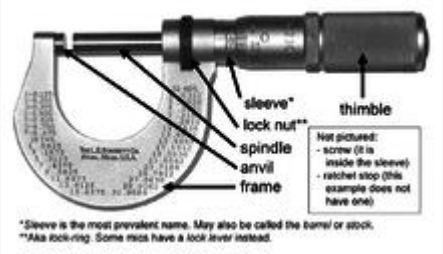
Micrometers use the principle of a screw to amplify small distances[6] (that are too small to measure directly) into large rotations of the screw that are big enough to read from a scale. The accuracy of a micrometer derives from the accuracy of the thread-forms that are central to the core of its design. In some cases it is a differential screw. The basic operating principles of a micrometer are as follows:

- The amount of rotation of an accurately made screw can be directly and precisely correlated to a certain amount of axial movement (and vice versa), through the constant known as the screw's *lead*.
- With an appropriate lead and major diameter of the screw, a given amount of axial movement will be *amplified* in the resulting circumferential movement.

For example, if the lead of a screw is 1 mm, but the major diameter (here, outer diameter) is 10 mm, then the circumference of the screw is 10π, or about 31.4 mm. Therefore, an axial movement of 1 mm is amplified (magnified) to a circumferential movement of 31.4 mm. This amplification allows a small difference in the sizes of two similar measured objects to correlate to a larger difference in the position of a micrometer's thimble. In some micrometers, even greater accuracy is obtained by using a differential screw adjuster to move the thimble in much smaller increments than a single thread would allow.

In classic-style analog micrometers, the position of the thimble is read directly from scale markings on the thimble and shaft. A vernier scale is often included, which allows the position to be read to a fraction of the smallest scale mark. In digital micrometers, an electronic readout displays the length digitally on an LCD on the instrument. There also exist mechanical-digit versions, like the style of car odometers where the numbers "roll over".

Parts:



The parts of a micrometer caliper, labeled. (Notice also that there is a handy decimal-fraction equivalents chart printed right on the frame of this inch-reading micrometer.)

A micrometer is composed of:

Frame:

The C-shaped body that holds the anvil and barrel in constant relation to each other. It is thick because it needs to minimize flexion, expansion, and contraction, which would distort the measurement.

Anvil:

The shiny part that the spindle moves toward, and that the sample rests against.

Sleeve / barrel / stock. The stationary round component with the linear scale on it. Sometimes vernier markings.

Lock nut / lock-ring / thimble lock:

The knurled component (or lever) that one can tighten to hold the spindle stationary, such as when momentarily holding a measurement.

Screw:

The heart of the micrometer, as explained under "Operating principles". It is inside the barrel.

Spindle:

The shiny cylindrical component that the thimble causes to move toward the anvil.

Thimble:

The component that one's thumb turns. Graduated markings.

Ratchet stop:

Device on end of handle that limits applied pressure by slipping at a calibrated torque.

Metric system:

Micrometer thimble reading 5.78mm

The spindle of an ordinary metric micrometer has 2 threads per millimeter, and thus one complete revolution moves the spindle through a distance of 0.5 millimeter. The longitudinal line on the frame is graduated with 1 millimeter divisions and 0.5 millimeter subdivisions. The thimble has 50 graduations, each being 0.01 millimeter (one-hundredth of a millimeter). Thus, the reading is given by the number of millimeter divisions visible on the scale of the sleeve plus the particular division on the thimble which coincides with the axial line on the sleeve.

Suppose that the thimble were screwed out so that graduation 5, and one additional 0.5 subdivision were visible (as shown in the image), and that graduation 28 on the thimble coincided with the axial line on the sleeve. The reading then would be 5.00 + 0.5 + 0.28 = 5.78 mm.

A snap gage is a form of Go/no go gauge. It is a limit gauge with permanently or temporarily fixed measurement aperture(s) (gaps) which is used to quickly verify whether an outside dimension of a part matches a preset dimension or falls within predefined tolerances.

Plug Gauge:

These gauges are referred to as plug gauges. They are used in the manner of a plug. They are generally assembled from standard parts where the gauge portion is interchangeable with other gauge pieces (obtained from a set of pin type and a body that uses the collet principle to hold the gauges firmly. To use this style of gauge, one end is inserted into the part first and depending on the result of that test, the other end is tried.

In the right image, the top gauge is a thread gauge that is screwed into the part to be tested, the *GO* end should fully enter the part; the *NOT GO* end should not. The lower image is a plain, plug gauge used to check the size of a hole; the green end is the *GO*, and the red end is the *NO GO*. The tolerance of the part that this gauge checks is 0.30mm where the lower size of the hole is 12.60mm and the upper size is 12.90mm,

every size outside this range is *out of tolerance*. This may be initially expressed on the parts drawing in a number of styles; three possibilities may be

- 12.75mm +/- 0.15mm
- 12.60mm +0.30 -0.00
- 12.90mm +0.00 -0.30

A ring gauge, or ring gage, is a cylindrical ring of a thermally stable material, often steel, whose inside diameter is finished to gauge tolerance and is used for checking the external diameter of a cylindrical object.

Ring gauges are used for comparative gauging as well as for checking, calibrating, or setting of gauges or other standards. Individual ring gauges or ring gauge sets are made to variety of tolerance grades in metric and English dimensions for master, setting, or working applications.

"Go" spline ring gage

There are three main types of ring gauges: go, no go, and master or setting ring gauges.

Go ring gauges provide a precision tool for production comparative gauging based on a fixed limit. Go gauges consist of a fixed limit gauge with a gauging limit based on the plus or minus tolerances of the inspected part. A go ring gauge's dimensions are based on the maximum OD tolerance of the round bar or part being gauged. A go plug gauge's dimensions are based on the minimum ID tolerance of the hole or part being gauged. The go plug (ID) gauge should be specified to a plus gauge makers' tolerance from the minimum part tolerance. The go ring (OD) gauge should be specified to a minus gauge makers' tolerance from the maximum part tolerance.

No-go or not-go gauges provide a precision tool for production comparative gauging based on a fixed limit. No-go gauges consist of a fixed limit gauge with a gauging limit based on the minimum or maximum tolerances of the inspected part. A no-go ring gauge's dimensions are based on the minimum OD tolerance of the round bar or part being gauged. The no go ring (OD) gauge should be specified to a plus gauge makers' tolerance from the minimum part tolerance.

Master and setting ring gauges includes gauge blocks, master or setting discs, and setting rings are types of master gauges used to calibrate or set micrometers, optical comparators, or other gauging systems. Working gauges are used in the shop for dimensional inspection and periodically checked against a master gauge.

Accuracy Grades:

Similar to gage blocks, ring gauges are sold under different accuracy grades. The higher the grade, the lower the allowable variance from the nominal diameter. This diameter tolerance varies, within each grade, based on the nominal diameter. US standard grades are defined per ANSI/ASME B89.1.5.

Feeler Gauge:

A feeler gauge is a tool used to measure gap widths. Feeler gauges are mostly used in engineering to measure the clearance between two parts.

They consist of a number of small lengths of steel of different thicknesses with measurements marked on each piece. They are flexible enough that, even if they are all on the same hinge, several can be stacked together to gauge intermediate values. It is common to have two sets for imperial units (typically measured in thousandths of an inch) and metric (typically measured in hundredths of a millimetre) measurements.

A similar device with wires of specific diameter instead of flat blades is used to set the gap in spark plugs to the correct size; this is done by increasing or decreasing

the gap until the gauge of the correct size just fits inside the gap. The lengths of steel are sometimes called *leaves* or *blades*, although they have no sharp edge.

LESSON NO. 9
QUALITY MANAGEMENT SYSTEM QMS &TQM

International Organization for Standardization is called as ISO. It is an independent, non-governmental body. The ISO focuses on Process approach unlike product approach in conventional quality systems. The ISO 9000 series of standards is a set of guidelines for developing and demonstrating a documented Quality Management System. The term ISO 9000 refers to a set of quality management standards and currently includes three quality standards: ISO 9000:2000 (presents requirements), ISO 9001:2000 and ISO 9004:2000 (presents guidelines). ISO 9000:2000 Standards apply to all kinds of organizations in all kinds of areas. The various requirements in ISO are;

- Scope
- Normative Reference
- Terms and Definitions
- Quality Management System
- Management Responsibility
- Resource Management
- Product Realization
- Measurement, Analysis and Improvement

Apart from the above, the following are the pre-requisites of ISO implementation:

- Quality Manual
- Six Mandatory Procedures
    - Control of Documents
    - Control of Records
    - Internal Audits
    - Control of Non-conforming Products
    - Corrective Action
    - Preventive Action
- Work Instructions, if any
- Formats, forms, flow process charts etc.

Significance of ISO Certification:

- It helps in setting all documents in order.
- The customers feel more confident with organization having quality management system, as it provides them with visibility and verifiability about the organization, its systems and even products.

- The certified organization gets mentioned in important product guides etc and attract more business.
- The employees of ISO organization have greater opportunities of learning and contributing. This helps them to satisfy their esteem needs, bringing positive and enjoying work culture in the organization.
- It is a demonstrative power tool to organization to show that the organization can perform effectively in achieving quality and commitment to quality.

Importance of Customer in ISO:

The goal of a ISO certified organization is to achieve quality through continual improvement fulfilling requirements of customer and enhancing his degree of satisfaction. The following areas are focused on customer in ISO standard.

- Top management to communicate importance of meeting customer requirements (Clause 5.1)
- Customer requirements to be determined and fulfilled (5.2)
- Promote awareness of customer requirements (5.5.2)
- Unspecified requirements by the customer to be determined (7.2.1)
- Determine and implement effective arrangements for communication with customer (7.2.3)
- To monitor whether customer requirements are fulfilled (8.2.1)
- Analysis of data to provide information on the customer satisfaction (8.4)

Internal Audit:

An audit, in terms of ISO, is defined as a systematic, independent and document process for obtaining audit evidence and evaluating it objectively to determine the event to which audit criteria are fulfilled. An organization shall conduct internal audits at planned intervals to determine whether the quality management system

- conforms to the planned arrangements, to the requirements of this International Standard and to the quality management system requirements established by the organization, and
- is effectively implemented and maintained.

The purpose of internal auditing is to get confidence in the organization that the system is functioning effectively. The results of internal auditing i.e., number of non-conformities observed during the audit will reflex the customers satisfaction as well as continual improvement of the organization.

Sustaining ISO:

- Know and remember our customers and their requirements.

- Understanding and spreading the message of the quality policy of the organization and quality objectives of the shop / section.
- Ensuring that we contribute positively for the achievement.
- Ensuring proper housekeeping.
- Make available the applicable documents for reference as and when required. Examples of such documents are:
    - Railway Board / RDSO / BIS / IRS specification, guidelines etc.
    - Applicable plans / work orders etc.
    - Applicable drawings, sketches, catalog etc.
    - Applicable procedures, work instructions etc.
    - Ensure that the documents are the current ones and are legible. If any obsolete documents are in your possession, please get them exchanged for the current ones.
- Keeping sufficient number of copies of applicable formats for ensuring prompt filling up.
- Ensuring that only calibrated monitoring and measuring devices (MMDs) are used. If any MMD is due for calibration, identify the due date in advance and ensure prompt calibration. If any status indicating stickers or labels are defaced / missing, please get replacements immediately.
- Ensuring that areas are marked or tags are readily available fro identifying non-conforming products. Ensure that till non conformity situation is resolved, the NC products are not used even by mistake.
- Deputing personnel for training promptly advising them to attend the training on time and learn effectively during the training. After the training is completed, ensure that necessary feedbacks are complied with.
- Ensuring that personnel use personal protective appliances while carrying out the jobs.
- On the shop floor finished jobs must be stored neatly with identification tags and other records and wherever provided in the pallets only.
- Encouraging the staff to contribute useful suggestions to improve the productivity, quality and safety in the organization.
- Move the parts / jobs from one stage to another not just as a routine but only after ensuring satisfactory completion of the job and clearance.
- Ensure that all consumables are used only as required without any wastage.
- Ensure that all leakages in water lines, oil lines and compressed air lines are plugged since they drain resources badly.

LESSON NO. 10

EMS SYSTEMS IN WORKSHOPS

ISO 14000: ENVIRONMENTAL MANAGEMENT SYSTEM:

ISO 14000 is an International Standard which specifies requirements for an Environmental Management System, to enable an organization to formulate a policy and objectives taking in to account legislative requirements and information about significant environmental impacts. It applies to those environmental aspects which the organization can control and over which it can be expected to have and influence.

This International Standard is applicable to any organization that wishes to:

- Implement, maintain and improve an environmental management system
- Assure itself conformance with it's stated environmental policy
- demonstrate such conformance to others
- Make a self determination and self declaration of conformance with this International Standard**.**

Benefits of ISO Certification:

- Customers and users will get benefited by receiving the products that are conforming to the requirements, dependable and reliable, available when needed and maintainable.
- People in the organization will get benefited by better working condition, increased job satisfaction, improved health and safety, improved morale, improved stability of employment.
- Owners and investors will get benefited by increased return on investment, improved operational results, increased market share, increased profits.
- Suppliers and partners will get benefited by stability, growth, partnership and mutual understanding.
- Society will get benefited by fulfillment of legal and regulatory requirements, improved health and safety, reduced environmental impact, increased security

LESSON NO. 11

VALUE ENGINEERING, TYPES OF NEEDS AND DEMANDS

Value Engineering is a function oriented, systematic team approach and study to provide value in a product, system or service. Often, this improvement is focused on cost reduction; however other important areas such as customer perceived quality and performance are also of paramount importance in the value equation.

Value=function/cost

To increase value, increase functions or decrease cost.

Value Engineering techniques can be applied to any product process procedure system or service in any kind of business or economic activity including health care, governance, construction, industry and in the service sector.

Value Engineering focuses on those value characteristics which are deemed most important from the customer point of view.

Value Engineering is a powerful methodolgy for solving problems and/or reducing costs while maintaining or improving performance and quality requirements.

Value Engineering can achieve impressive savings, much greater than what is possible through conventional cost reduction exercise even when cost reduction is the objective of the task.

Benefits of Value Engineering:

- Lowering O & M costs
- Improving quality management
- Improving resource efficiecy
- Simplifying procedures
- Minimizing paperwork
- Lowering staff costs
- Increasing procedural efficiency
- Optimizing construction expenditures
- Developing value attitudes in staff
- Competing more successfully in marketplace

Value Engineering helps you to learn how to :

- Improve your career skills
- Separate "Symptoms" from "problems"

- Solve "root cause" problems and capture opportunities
- Become more competitive by improving "benchmarking" process
- Take command of a powerful problem solving methodology to use in any situation

The Value Engineering(VE) Process and Job Plan:

A common response heard when discussing the VE process or the requirements to conduct VE studies is "we do it all the time, but we just don't call it VE!"Because the VE process contains many elements and phases, such as team work, functional analysis, "brainstorming", and cost-worth analysis, unless a review conducted for a particular project includes these and other related elements and phases, it is not considered to be VE.

The FHWA defines VE analysis as: A systematic process of review and analysis of a project, during the concept and design phases, by a multidiscipline team of persons not involved in the project, that is conducted to provide recommendations for:

- providing the needed functions safely, reliably, efficiently, and at the lowest overall cost;
- improving the value and quality of the project; and
- reducing the time to complete the project.

Simply stated, VE is an organized application of common sense and technical knowledge directed at finding and eliminating unnecessary costs in a project.

The "systematic application of recognized techniques," referred to in the above definition is embodied in the VE Job Plan. The Job Plan is a systematic and organized plan of action for conducting a VE analysis and assuring the implementation of the recommendations. The methodology utilized for any VE analysis shall follow widely recognized systematic problem-solving procedures that are used throughout private industry and governmental agencies.

The Job Plan contains eight phases. The first phase is completed prior to the commencement of the VE analysis, six of which are performed by the VE team, and one that is conducted to "close out" the process. Each phase of the Job Plan includes several tasks. It is the melding of the various tasks and techniques, coupled with finesse in their application that makes the VE process work.

The following table summarizes the VE Job Plan and provides a link to additional discussion on key considerations associated with each of the eight phases:

- Selection of projects for VE analysis
- Investigation (gathering of information)
- Function Analysis (analyzing functions, worth, cost, performance and quality)

- Creative (speculating using creative techniques to identify alternatives that can provide the required functions)
- Evaluation (evaluating the best and lowest life-cycle cost alternatives)
- Development (developing alternatives into fully supported recommendations)
- Presentation (presenting VE recommendations for review, approval, reporting and implementation)
- Close Out (Implementing and evaluating of the outcomes of the approved recommendations)

Selection:

The responsibility to select the projects for a VE study is usually outside the control of the study team. Beyond the Federal requirements for conducting studies, some criteria used to select projects include but are not limited to:

- high-cost and/or high-priority projects
- important, but lower priority projects, that fail to meet the transportation agency's budgetary cut-off
- complex or challenging projects with multiple stages or complicated/costly traffic control and staging
- projects with extensive or costly environmental or geotechnical requirements
- projects that substantially exceed their initial cost estimates
- projects that have encountered "scope creep"
- projects involving multiple stakeholders
- projects that involve the use of other quality and cost review techniques (Road Safety Audits, Context Sensitive Solution workshops, Risk Based Cost and Schedule Estimates)
- corridor or route planning studies

Investigation:

The Investigation (or Analysis) Phase is where the study team first becomes involved. In this phase, the team determines what they know about the project from readily available information and what they must know in order to really define and/or solve the problem. It is in this phase of the VE study that the elements that have the greatest potential for value improvement are identified.

The Investigation Phase immediately brings the three fundamental concepts of VE (function, cost, and worth) to bear on the problem. It is these concepts that make the VE process different from all other management and cost control techniques. This phase requires the team to ask and answer the following basic questions:

- What is it?
- What does it do? (what is the function?)
- What must it do? (is its function basic?)
- What is it worth?
- What does it cost?

Most of the information required in this phase is readily available. The length of the project, its cost estimate, traffic projections, design speeds, and the major elements designed into the project can be easily identified from a review of the plans and other documentation. Sometimes the VE team must investigate further for other information necessary to adequately complete the investigation phase.

Applying Pareto's Law of Distribution is helpful when beginning to look for potential savings. Pareto's Law states that 80% of a project's cost will be in 20% of the work. Preparing a project cost model will begin to identify targets of opportunity.

Identifying the functions the project and its elements perform is the next step in the Investigation Phase. Function denotes the specific accomplishment to be achieved by an element or combination of elements in the overall design. The value methodology requires that we describe a function by the use of two words - an action verb and a measurable noun (that is acted upon).

For example, the function of a bridge is to "cross obstacle." The VE study team should not care whether that obstacle is a ditch, river, creek, railroad, another highway or a building. The bridge's basic function is to provide a means to cross that obstacle. If it does not accomplish that function, we wouldn't buy it, therefore the cross obstacle function is considered to be basic. The study team should be as non-specific as possible when describing functions to leave as many options open as possible to perform the generalized problem or function that the project presents.

To summarize, the goals of the VE study team by the end of the Investigation Phase are to:

- Identify the project's high-cost elements
- Conduct a functional analysis of the high-cost elements
- Assess their cost / worth relationships

Creative:

The Creative (also referred to as Speculation) Phase follows Investigation and is where the power and the benefits of the VE technique are manifested. The team applies brainstorming techniques to develop viable alternatives to the way the project is currently designed. Brainstorming forces people to be creative. The mechanism that produces this phenomenon is called synergism --one idea triggers other ideas or thoughts through: similarities or like ideas; contiguous or adjoining ideas; contrasting or opposite ideas; and sound alikes.

The value study team applies creativity to the functional statements selected from the previously conducted cost/worth estimates. The team uses the generic format of the function to speculate on all possible solutions to the problem presented in that functional statement.

The VE study team uses brainstorming to generate a large list of potential solutions to the problem described by the two-word function, which prepares the team to enter the next phase, when they are charged with paring down a laundry-list to a manageable few ideas through the feasibility analysis.

Evaluation:

During the Evaluation Phase, the advantages and disadvantages of each remaining alternative are listed. Each advantage and disadvantage is described in general terms. The team can perform a weighted matrix analysis to determine which alternative is best based upon the relative importance of each of the desirable criteria which must be addressed. Of course, if the disadvantages are found to far outweigh the advantages of any alternative, the alternative is dropped from further consideration at this point. Conducting this analysis satisfies the VE objective--to achieve the best blend of performance, cost, and schedule. Perfection is not the objective of the VE study team.

Development:

Once the team selects the best alternatives, they are fully developed through sketches, cost estimates, validation of test data, and other technical work to determine if any assumptions made during the study are in fact valid. The Development Phase is the final step before presenting the team's recommendations to the agency's management. The study team formulates an implementation plan which describes the process that the agency must follow to implement any recommendations.

Presentation:

The final product of a VE study is the formal VE Report and the presentation of the team's recommendations. In this phase, the VE team presents their findings to the project decision makers, and strives to convince them that their ideas should be implemented.

This formal presentation should be brief but thorough, with sufficient time allocated for discussion and responding to questions. When making the presentation, the study team should exercise care when presenting estimated cost savings or, in some cases, increased costs associated with recommendations. Overstating or double counting savings should be avoided. For VE studies taking a longer time to complete, it

is beneficial for the study team to provide progress updates to the appropriate project management staff.

The VE Report serves as a step-by-step record of the work accomplished during the preceding phases. The report provides documentation to support the team's recommendations, tracks the team's deliberations and considerations, and aids in implementation of the recommendations. It can also be a useful reference tool for future projects and VE studies that must address similar topics.

Close Out/Implementation:

No recommendation for cost savings can achieve savings until it has been implemented. Although it may not be practicable to implement each and every recommendation proposed, the project decision makers must take the appropriate action to ensure that a fair and serious consideration of the proposed recommendations occurs. A key activity of the Implementation Phase is the information sharing within the transportation agency as the recommendations are implemented --- and the associated savings are realized --- on projects. Not only does this activity promote the benefits associated with conducting the VE studies, it will provide benefit to future transportation projects.

The final phase of the Job Plan also involves determining the actual amount of savings generated by the VE analysis based on the amount of recommendations implemented in the construction project and evaluating the outcome the recommendation achieved in the project.

LESSON NO. 12
PRODUCTION CONTROL ORGANISATION

The aim of any industrial concern is to obtain the maximum utility of machine, material and men in a most economic way. To achieve this it is essential to have a systematic organization called Production Control Organization

The main objective of this organization is to see that the production activities are arranged and co-ordinate at all stages of production, so that planned instructors and schedules are adhered to supplies are obtained in time and work is synchronized, there by holds ups are persuaded and production is kept at optimum capacity. It is further aims at simplified of procedures and avoids wastage of materials, labor and machine usage and therefore ensures economy at all stages. This organization is under the control of production engineer. As production engineer and its integrated scheme consists of three main sections.

- Planning and rate fixing section
- Progress section
- Inspection wing

Planning and Rate Fixing Section:

Planning and rate fixing section deals with pre-planning and rate fixing process. The pre-planning section ensures that all the shop manufactured items are within the scope of manufacture with the plant available. It also decides whether a particular item has to be manufactured from a bar, plate, forging, drop, stamping, casting etc. The function of the progress section is to lay down the sequence of operations of the ship manufactured items, through their various stages of manufacture, with due regard to modern production methods and facilities available in shops, keeping in vew the load of the various sections and shops.

For this purpose, the P&R section studies the layout of the shop in which it is proposed to manufacture a particular item, selects suitable machine and departments, decides the best and economical methods, decides jigs and fixtures found necessary and plans machinery of one or none per setting etc.

The Rate fixing section is responsible for fixing the allowed time for various operations. The rate fixes specifies the preparation times per batch quantity and enhanced time per piece. The production documents are then printed in adrame section and issued to shops through progress section.

Duties of Planning and Rate Fixing Section:

- Pre-planning of all the activities to be undertaken in shops.
- Identify the infrastructure required for the activities undertaken
- Preparation of estimate for various activities.
- Ensure the budget provision and grants for the activities (EAR). (Estimate of Annual Requirement). (Now ZBB, zero based budgets)
- Procurement of materials either by shop manufacture or through trades
- Preparation of C&D (cost and detail book)/schedule/scroll process sheets for shop manufacturing items.
- Fixation of allowed time duly conducting time study.
- Maintenance of statistical details (like incentive statements, energy consumption etc).
- Preparation of incentive proposal, staff proposed etc. (Man power planning).
- Securitization of tender documents for technical suitability and rate reasonableness.
- Inventory control
- Conducting method studies

Main Activities of P & R Dept:

- Incentive-Quarterly and half yearly statements
- Job cards and computation sheets correspondence with time office and SAO/MYS.
- Correspondence with HQs
- Drawing correspondence
- Load and capacity of shops
- Monthly return of out turn statement of foundry shop, cost statements of ferrous and non ferrous costing.
- Stores correspondence, Returning of issue notes to stores, certification of bills for the supply of materials.
- PCDO (Performance Center Dumony Official) correspondence energy consumption, quality circles.
- Rolling stock programme
- POH of BG coaches, BG material planning, unit cost, POH of corrosion coaches, cycle time correspondence.
- Railway Board, RDSO instructing regarding C&W and list of approved items.
- Other activities like method study, work for Dussera exhibition, out station memo, spot checks, CWE/CME's inspection reports.

- Estimation of re-building of X-class locomotives, toys trains etc. work contract, conversion of averaged coaches to BD/ART coaches (Breakdown, Accident relief train). Conversion of condemned coaches into MRV, RHV (Medical relief van, Auxiliary Relief Van) Pantry car etc.

List of Standard Railway Forms used in RF & P:

SRF1 Scroll process sheet
SRF2 Process sheet
SRF3 Root card
SRF4 Root card for replacement
SRF5 Job card
SRF6 Job card for replacement
SRF7 Job card for squad work
SRF8 squad summary card
SRF9 proceeding time card for squad work
SRF10 material requisition
SRF11 material tag
SRF12 material requisition replacement
SRF13 material tag replacement
SRF14 workshop issue slip
SRF15 day work card
SRF16 Ideal time card
SRF 17 Idle time slip
SRF18 suspended job slip
SRF19 Resumption of suspended job slip
SRF20 Entrusting the job in progress to another operator
SRF21 List of gate attendance and job card for night shift
SRF22 Special allowance card
SRF23 Inspection form
SRF24 Process and overtime alteration
SRF25 Request for investigation
SRF26 Out station time card
SRF27 Gate attendance card

Manpower Planning:

Man power planning is the process of assessment and estimation of man power requirement for various activities performed in the work shop.
Elements of activities are separating studied and timings are arrived.

Man power requirements is assessed whenever

- Activities of workshop changes
- Out-turn of the shop changes
- Allowed timer change

Procedure:

- Allowed time for various elements of activities are calculated using time study and method study.
- Total hours per month of that particular element is arrived at by considering the total out turn/month
- Direct man power required is calculated by dividing total hours (month by 267 (200 hours/month by every employee X 1.33 i.e. bonus incentive))
- Leave reserve of 12.5% is added to this requirement, which gives direct workers man power requirement.
- 12% of EIW (Essentially Intermittent workers) and 3% of IW (Indirect workers) is added to this
- In EIW, 2/3rd workers should be Group C employees and 1/3rd should be group D staff.
- All the IW should be Group D employees [Group D – khalasi & khalasi helper]
- Average break up of Group C employees
    - MCM – 5% Sr. Tech
    - HS I – 35% Tech I
    - HS II – 30% Tech II
    - HS III – 30% Tech III

- For every 18 employees, one supervisor is required.

Example**:**
Allowed time for a particular activity = 600 hours/coach
Out turn = 50 coaches/month
Direct workers required = (600 X 50)/267 = 112 men
Leave reserve @ 12.5% = 112 X 0.125 = 14 men
EIW @ 12% = 112 X 0.12 = 13
Group C employees @ 2/3 = 9 (approx)
Group D employees @ 1/3 = 4 (approx)

Total DW (direct workers) + EIW (Group C) = 112 + 14 + 9 = 135
No. of men's @ 5% = 135 X 0.05 = 7
No. of HSI @ 35% = 135 X 0.35 = 47
No. of HSII @ 30% = 135 X 0.30 = 41
No. of HSIII @ 30% = 135 X 0.30 = 41

No. Indirect workers @ 3% = 0.03 X 112 = 3
Total workers required = 112 + 14 +13 + 3 = 142 men
Group D employees = 4 + 3 = 7
No. of khalasis @20% = 1
No. of khalasi helpers @ 80% = 6
No. of supervisors @ 1 for 18 = 142/18 = 7.8 ~ 8

LESSON NO. 13
PROCESS INVENTORY CONTROL - PROGRESS SECTION

Functions of Progress Department:

- Maintaining stock requirement of workshops.
- Releasing of work orders.
- Follow up actions.
- Supply of material from stores to the shops.

This section is responsible for the execution of the planed workload. In doing so, they will release work orders for all types of work i.e., undertaken in the workshop. Progress section will arrange for the supply of raw materials in time to the concerned shops. They will follow up all the activities and put uo the position to works officers. In the process of follow up if there are any hurdles or constraints, the progress staff will immediately take action to solve them and see that the job is processed according to the time schedule. They will watch over the item going out of stock and prepare a out of stock list, periodically and discuss the issue with the stores department and arrange for getting the material either from trade or from the sister shop and sister depots. Apart from the out of stock items, there will be some vital items, which need more attention and therefore a meeting at the depot level or head quarters level will be arranged every month.

On the shop floor the progress staff will see that the work order lists are completed as per the target date. They will follow the job, operation wise, stage wise etc. Periodical meetings to discuss the position and the probable date of completion, will be arranged by the progress staff with the concerned SSE/SEs and the work officers.

All the local purchases will also attend to by the progress staff. Assistance in getting raw material from other workshops and other depots will be chased by the progress staff duly going on out station duty. It is the responsibility of the progress section to feed the shop with the work load, raw material etc and see that the jobs are executed as per the time schedule.

Work Order System:

Work order is the primary cost center on which the expenditure of the is identified and recorded. The basic data is furnished on the job cards, computation sheet, indent/requisition, issue notes, charge man diary etc. Work order number consists of 8 digits. There is no check digit in the work order number.

- First digit indicates whether work order is released in the first half or 2nd half of the year.
- 2nd digit indicates the last digit of the year.
- 3rd digit indicates whether it is a fresh w.o. or repetitive.

- 4th digit indicates the work shop code.
- Last four digit indicate running serial number

Work Orders are Classified as Follows:

On cost Work Order(General on Cost and Shop on Cost):

Expenditure which cannot be charged direct to the cost of the article or work done are termed as on cost work orders.

Ex: 50530001

50- code for on cost work done

5- year i.e. 1995

3- shop code (Ashoka poram)

0001-Serial number

Standing Work Order:

These are the work orders issued for ready use by the shop for various activities i.e. POH/IOH of loco/Carriage/Wagon, repairs to machinery

Ex: 60345678

60-code for standing work order

3- Work shop code (AP)

45678- Serial number

Departmental Work Order:

These are work orders issued, especially for the compliance requisition placed by various departments of railway like medical department, stores, security department, electrical department, engineering department, commercial department, Accounts department etc. In this type of work orders there may be repairs and return or manufacture and supply.

Ex. 33935678

1st digit indicates division codes

Division Codes :

3 – Work done for home railway/misc

4 - Work done for foreign Railway

5 - Work done for SBC/MYS division

6 - Work done for PGT/TVL divisions

7 - Work done for TPJ/MDU divisions

8 - Work done for MAS divisions

9 - Work done for construction department

2nd digit of the department work order indicates departmental code

0 – for construction department

1- for traffic and commercial department

2 – for electrical department
3 – for mechanical department
4 – for medical department
5 – for personal/accounts/HQ and general
6 – for security department
7 – for signal and telecommunication department
8 – for stores department
9 – for engineering department

3rd digit of the departmental work order indicates the year(last digit of the year)
4th digit indicates the workshop code i.e. 3 for AP
Last four digits indicate the serial number of the work order.

Part – Group – Repair Work Orders:

At Mysore workshops the repair work orders from division are not related through the stores depot as such the repair work orders from stores are not issued.

Part and group orders are released for the manufacturing of store stock orders based on the SRW (stores requisition to workshop) placed on workshop by DCOS/AP. Part orders are classified as loco part orders and carriage part orders (carriage part orders include wagon part orders). Group orders are also classified as loco group orders and carriage group orders. Part/Group work order number is as explained in work order system.

Capital Work Order, Special Work Order:

These are work orders issued for the construction of coaches, UIC bogies etc. These work orders are issued on the basis of the estimate sanctions.

Inspection wing of PCO:

The main activities of inspection wing are classified as

- Pre- inspection.
- Stage- inspection.
- Final-inspection.

Pre- Inspection:

During this phase of inspection the quantum of repairs are estimated and written communication is given to the concerned shop in form no.This pre-inspection is applicable to the repair shops which under takes the repairs on condition basis. As for as corrosion repairs are concerned, the pre inspection is carried out to advise the renewal of body side panels, sole bars, head stocks, Trough floor, Cross members and partition walls etc.

Stage inspection:

During this inspection the items which are not visible during pre-inspection (hidden) are checked thoroughly to ascertain the repairs more accurately and it is also

observed that laid down procedure is being followed for carrying out repairs and right materials are being used. If any deviations are found the inspector will stop the repair work and insist on following the right procedure.

Final inspection:

After completion of the repairs, the coaches or the sub assemblies are offered to the inspector for final inspection. During final inspection, the works marked in pre & stage inspection are checked thoroughly .Special attention is being paid to check the clearances, alignment, condition of renewed parts, workmanship, and aesthetic look, firmness of fitted parts, operational functions of the systems available. If all the aspects are found satisfactory the coach or the assembly is allowed to move from the inspected shop to next shop for further repairs in sequence. The same procedure is followed in the next shop till final operation.

At the time of turning out the coach from the shops it is mandatory to get inspected by Neutral Train Examiner also in addition to shop inspector.

LESSON NO. 14
INDUSTRIAL SAFETY REQUIREMENT AND PROCEDURE

“Safety is a situation of being safe or an accident free situation.”

An industrial accident may be defined as an event, detrimental to the health of a man suddenly occurring and originating from external sources, and which is associated with the performance of a paid job, accompanied by an injury followed by disability or even death. An accident may happen to any employee Under certain circumstances.

Causes of accidents:

- Technical causes - unsafe conditions-mechanical/environmental factors
- Human causes - unsafe acts-personal factors.

Mechanical:

- Unsafe mechanical design or construction.
- Hazardous arrangement (piling, overloading).
- Improper machine guarding.
- Unsafe apparel.
- Defective agencies or devices.
- Improper material handling.
- broken safety guards.
- Protruding objects.
- Leaking acid valves.
- Untested boilers or pressure vessels.

Environmental factors:

- Too low temperature to cause shivering.
- Too high temperature to cause headache and sweating.
- Too high humidity to cause uncomfort.
- Defective and inadequate illumination.
- Presence of dust and fumes.
- High speed of work due to huge work load.
- More number of working hours.
- Inadequate rest pauses.
- Noise, bad odor.
- Poor housekeeping.

Personal factors:

- Age
- Health.
- Number of dependents.
- Financial position.
- Home environment.
- Lack of knowledge and skill.
- Improper attitude towards work.
- Incorrect machine habits.
- Carelessness and recklessness.
- Day –dreaming and in attentiveness.
- Fatigue.
- Emotional in stability.
- High anxiety level.
- Mental worriness.
- Unnecessary exposure to risk.
- Non use of safety devices.
- Working at unsafe speeds.
- Improper use of tools.

Accident Prevention:

Accident prevention is highly essential in an industry, in order to

- Prevent injury to and premature death of employees.
- Reduce operating and production costs.
- Have good employer-employee relations.
- High up the morale of employees.

Above all prevention of accidents is a true humanitarian concern. Accident prevention does not occur by itself; there should be consistent implementation of safety measures and safety.

Programmes emphasizing the need for

- Safe workplace layout and working conditions.
- Safe material handling.
- Personal protective devices.
- Safety activities in the organization.

Safe Workplace Layout and Working Conditions Layout:

Although most accidents take place because of unsafe act of the employees, the role of the environments and surroundings cannot be ignored in determining the cause of

accident. A good layout and working conditions play a major role in preventing many accidents which would have otherwise occurred.

For preventing accidents, the layout should be such that:

- Every employee has enough space to move and operate.
- Passageways between working places, roads, tracks and alleys etc., must never be obstructed.
- It prevents the inrush of cold/hot air and draughts to the working place.

For adequate lighting, ventilation, etc., the heights of the working rooms should be of 3 metres. Floors must be of nonskid type, satisfactorily plane and must possess such properties that they can be easily cleaned and absorb sounds. Windows should be of adequate dimensions in order to make full use of natural day light. Doors and gates leading to open should be provided with ' guards, etc., to prevent draughts at the neighboring workplaces. Fire hazards can be reduced by utilizing fire walls to separate manufacturing area into several compartments. A worker operating on the machine should have easy access to the safety switches provided on the machine/near workplace.

Working Conditions:

In enclosed rooms, in order to have comfortable conditions, the following should be controlled:

Air temperature, air purity, velocity of air, humidity of air and heat radiations between bodies of different temperatures.

Not only in enclosed rooms, even otherwise proper ventilation is a must if the manufacturing processes give rise to dust, smoke, fumes etc.

Whether natural or artificial, there should be sufficient illumination, of adequate color of light, continuous and uniform and free from glare.

A high noise level at the workplace impairs men at work and may even endanger them. Noise develops from riveting, grinding, forging, engines, compressors, etc. To reduce noise level and to minimize detrimental effects (e.g. deafness arising out of it,

- Select, purchase and make use of machines and processes which produce little noise.
- Isolate and keep noise producing machines in separate closed cabins.
- Use silencers to minimize the hissing sound of compressed air escaping from blow-off valves in pneumatic tools and machines.
- Use suitable machine mounts to damp down the vibrations.

Safe Material Handling:

Careless handling of heavy materials and components is a major source of back and foot injuries.

To avoid premature fatigue of transport workers, full use should be made of

mechanized materials handling equipment.

Use mechanical means of conveyance to ensure the safety of men engaged in material handling.

The transport workers should not be asked to lift more than the permissible load, *e.g.,* for a boy of 16 to 18 years of age, this load is 19 kgs.

During transport, sharp materials, sharp edged goods, poles, etc. should be covered, placed in stable holders and retained by means of wire.

Goods should be piled up such that they do not collapse due to impact or vibrations. Containers or vessels employed to transport liquids or small parts

- should not be too large to limit the range of vision and impede lifting and carrying,
- should be light, and
- should not be defective/leaking.

Depending upon the condition of material use a proper material handling equipment. All material handling equipments should be promptly repaired and adequately maintained on priority basis.

Personal Protective Devices for:

- *Protection of head*
  - Safety hard hats.
  - Rubberized hats for protection against liquids (chemicals).
  - Ear protectors.
- *Protection of face*
  - Face mask.
  - Face shields.
  - Welding helmets.
- *Protection of eyes*
  - Goggles of case-hardened and clear glass for protection against impact.
  - Eye cup goggles for protection against flying objects and dust.
  - Eye cup goggles impervious to chemicals for protection against acids/ alkalies splashes.
- *Protection of lungs*
  - Air line respirators.
  - Cartridge respirators.
  - Oxygen or air-breathing apparatus.
  - Gas mask.
- *Protection of other body parts, e.g., hand, foot, leg, etc*
  - Protective asbestos clothing.
  - Gloves.

- Safety shoes.
- Foot guards.
- Safety body belt.
- Aprons.
- Safety (moulder's) shoes.

Safety activities in the organization:

Other *safety measures* which may be adopted are:

- Provide wire mesh *safety guards* to all rotating parts, e.g., pulleys, etc.
- High voltage equipments and other machines which cannot be properly guarded should be *fenced.*
- Pressure vessels and their component parts *(e.g.,* valves, gauges, etc.) should be periodically tested as per their specifications; the defective parts should be replaced.
- Material handling equipments should have unobstructed paths to move on.
- Defective tools, *e.g.,* hammers, spanners etc., should be immediately replaced.
- Power should be switched off before repairing the equipment
- Inflammable materials should be stored separately and away from the general store.
- Electrical connections and insulation should be checked at regular intervals.

To avoid electrical accidents

- None except the electrician should be permitted to touch the electrical connections.
- All live wires should be isolated and insulated from each other.
- Electrical connections and ground connections of all portable and unportable machinery should be checked periodically.
- Damp environmental conditions (floor, etc.) should preferably be avoided.
- Fire extinguishers should be kept in proper condition and at key place

Accident Proneness:

- Examination of safety records often show that out of all the workers doing the
- same job and being subjected to the same physical environments, only a few have substantially more accidents than the rest.
- Such few workers who are found consistently to experience more accidents than the average (other) workers, are classified as ACCIDENT-PRONE workers/employees.
- ACCIDENT PRONENESS may be defined as the continuing tendency of a person to have more accidents as a result of his persisting characteristics, etc.
- Accident proneness is perhaps because of peculiar psychological and physiological make up of certain persons.

Causes of Accident Proneness:

- Inattentiveness and day-dreaming.
- Poor eyesight and hearing and lack of stamina. (iii) Poor adjustment of work; distaste for the job.
- Too much sensitiveness and tendency to get perturbed easily. (Emotional stresses)
- Dislike of the supervisor/foreman, etc.
- Lack of training, proficiency and skill to do a work.
- Insufficient intelligence.
- Unsafe behaviour of the worker *(e.g.,* intentionally not using safety devices and safe practices.

Methods to Reduce Accident Proneness:

- Depending upon the job conditions select only those applicants who possess appropriate standards of physical and mental ability
- Transfer accident prone workers to comparatively less hazardous job situations.
- ij Impart adequate training to a recruit before putting him on the job.
- Encourage employees working under you and see that they do not get unnecessarily perturbed, frustrated or emotionally disturbed.

Need for Safety:

- Safety in industry helps:
- Increasing rate of production.
- Reducing production cost.
- Reducing damage to equipment and machinery. Preventing premature death of talented workers who are an asset to the society.
- Preventing needless pain and suffering to its employees.

Organization for Safety

- In a small concern each shop supervisor may be made responsible for safety
- in his shop.
- Each shop supervisor may report to top executive as regards safety matters.
- Since the shop supervisor has its main job to turn out production, he may treat safety as a secondary aspect.
- For this reason sometimes the safety function is taken care of by personnel officer
  or general foreman.
- With the growth in the size of the industry and depending upon the

hazardousness of processes/operations, a full fledged safety department may be created with the safety Director/Manager as its chief executive and a number of persons under him at different levels.

- The Safety Director/Manager may be given a lineI position or staff position depending upon the conditions in the industry.
- Sometimes the responsibility for safety rests on a safety committee.

Safety Committee:

- A safety committee may consist of executives, supervisors, and shop floor workers.
- Thus the lower level employees get a channel of communication on safety matters direct to executive level.
- It was observed that those organizations which made safety committees had lower record of accidents than those without such committees.
- Safety committees aid in developing safety consciousness as well as it is a policy making body on such safety matters as come before it.
- The safety manager/executive requires a degree of firmness and ready discrimination to exclude personal and union matters in which safety is merely the pretext for their airing.
- The safety executive should guard jealously the responsibilities of management and supervision.

Lastly, to get maximum out of a safety committee

- It should be assigned specific problems and duties such as planning safety rules, publicizing them, etc.
- Its members should be asked to go on the shop floor and watch what is being done about it *(i.e.,* the safety)
- It should be asked to report periodically as what improvements have been made and what more can be done.

Safety Programmes:

- A safety programme tends to discover when, where and why accidents occur.
- A safety programme aims at reducing accidents and the Iosses associated with them.
- A safety programme begins with the assumption that most work-connected accidents can be prevented.
- A safety programme does not have an end; rather it is a continuous process to achieve adequate safety.
- A safety programme tries to reduce the influence of personal and environmental factors that cause accidents.
- A safety programme involves providing, safety equipments and special training to

employees.

A safety programme is composed of one or more of the following elements:

- Support by top management.
- Appointing a Safety Director.
- Engineering a safe plant, processes and operations.
- Educating all employees to work safely.
- Studying and analyzing the accidents to prevent their occurrence in future.
- Holding safety contests, safety weeks, etc., and giving incentives/prizes to departments having least number of accidents.
- Enforcing safety rules.

A safety programme includes mainly four E's:

- *Engineering i.e.,* safety at the design and equipment installation stage.
- *Education* of employees in safe practices.
- *Enlistment.* It concerns the attitude of employees and management toward the programme and its purpose. It is necessary to arouse the interest of employees in accident prevention and safety-consciousness.
- *Enforcement, i.e.,* to enforce adherence to safety rules and safe practices.

Safety Instructions and Training:

- This is essential for educating the employees to think, act and work safely so that the number of accidents can be minimized.
- Safety training/education gives knowledge about safe (and unsafe) mechanical conditions, personal practices and of the remedial measures.

Safety training involves:

- Induction and orientation of new recruits to safety rules and practices.
- Explaining safety function, during on-the-job training.
- Efforts made by the first-level supervisors.
- Formulating employee safety committees.
- Holding of special employee safety meeting.
- Displaying charts, posters, films etc..to emphasize the need to act safe

LESSON NO. 15
DRAWINGS USAGE, PREPARATION, MODIFICATIONS & ITS RECORD MAINTENANCE

Today it is common for a part to be designed in one country, manufactured in another and assembled in a third. This can be done efficiently with engineering communication via drawings. Engineering drawings communicate product design and manufacturing information in a reliable and unambiguous manner regardless of language. Information in engineering drawings is a legal specification that carry a binding contract

Sizes of the trimmed sheets of all drawings, except yard plans, should be as given bellow in Table..All plans required to be of longer length will be in the form of a roll, keeping the width as specified.

S No	Sheet Designation	Trimmed Size (mm) (WxL)	Remarks
1	A0	841x1189	Index Plan and Section. General arrangement and detailed drawings for road over bridges, major/ important bridge works & important structures, building (steel and concrete) etc.
2	A1	594x841	General arrangement.
3	A2	420x594	Temporary arrangement & detailed drgs. for bridge works, steel structures, building and temporary arrangement drgs. for Sr. No .1 above.
4	A3	297x420	Site plans for road over/road under bridges, passenger platform coverings, buildings etc. and drawings for minor detailing.
5	A4	210x297	Plans for inclusion in Works Programme booklets for handy reference, PERT charts of works of limited activities etc.

Requirements of engineering drawing:

- Unambiguous and clear (only one interpretation to be possible)
- Complete (Provide all information for all stages of manufacture. i.e., detailed drawings, assembly drawings, bill of materials)
- Suitable for duplication (Suitable scale and clarity that the drawing can be copied even micro copied without losing quality)
- Language independent (Words dependent on a language should only be used in the title block; words should be replaced by symbols)
- Conforms to standards (Highest standards are ISO as numerous countries learn these rules)

Types of drawings:

- Design Layout Drawing (Represents broad principles of feasible solution)
- Detail Drawing (Single part drawing containing all information for fabrication)
- Assembly Drawing (Shows how individual parts are combined, refers to parts list)
- Arrangement Drawing (Shows finished arrangement of assemblies, includes functional and performance requirements.
- Diagram (Drawing depicting the function of a system)
- Parts List -Bill of Materials (A parts this including material, number and provides reference number)
- Drawing List (Cross references drawings that all combine to produce a single product)

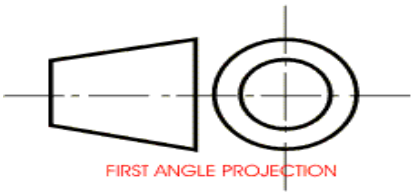
Number of views:

- Maximum 6 views
- Minimum 3 views
- Typical 4 views
- Central view is always the front view

Orthographic projections:

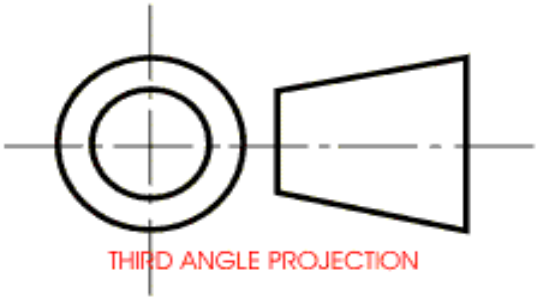
There are two ways of drawing in orthographic- *First Angle* and *Third Angle*.
They differ only in the position of the plan, front and side views.
First angle projection

- The view from above is placed underneath.
- The view from below is placed above.
- The view from the left is placed on the right.
- The view from the right is placed on the left.
- The view from the rear may be placed on the left or on the right, as convenient.



Third angle projection

- The view from above is placed above.
- The view from below is placed underneath.
- The view from the left is placed on the left.
- The view from the right is placed on the right.
- The view from the rear may be placed on the left or on the right, as convenient.



Drawing scale:

Ratio of the linear dimension of an element of an object as represented in the original drawing to the real linear dimension of the same element of the object itself

- Full scale :- A scale with ratio 1 : 1
- Enlargement scale :- A scale where the ratio is larger than 1:1

  Scale x : 1 , Ex :- 50:1 , 20 : 1, 2:1
- Reduction scale :- A scale where the ratio is smaller than 1:1

  Scale 1: x , Ex:- 1:2 , 1: 5, 1:20

Different specifications in drawings:

- IS specifications
- IRS specifications
- RDSO specifications
- ICF specifications
- RCF specifications

Types of Indian Railway Mechanical drawings

- IRS Drawings
- RDSO Drawings
- ICF Drawings
- RCF Drawings
- BEML Drawings
- DLW drawings

IRS Drawings:

- IRS drawings are mostly part drawings.
- Drawings are prepared separately for carriage and wagons
- Drawing No. are like W / BG - 6162, W/ BD –3142 , C/CF–6162, C/LF - 6263 .
- First digit of the drawing number indicates the drawing group i.e; Carriage or Wagon

RDSO Drawings:

- Drawings are prepared separately for carriages wagons and Diesel Locos
- Drawing are prepared in series and sketches.
- First two digits of the drawing number will be WD or SK or CG / WG
- WD / WG indicates for wagon , SK- is for Sketch either for carriage or wagon, in case of Sketch – Group , Carriage or Wagon will be indicated in drawing and CG for Carriage group
- Next two digits indicates year of drawing preparation.
- Next three digits serial No. of the drawing.
- Diesel drawings will be with numerical like 1, 2 , 3 etc

ICF Drawings:

- First two digits: Code T, EMU, WCB, SCN, WGSCWAC etc.
- Next two digits : group 00,01,02,03,04,05,06,07,08 etc.
- Next three digits: Serial No. 001, 002 for arrangement drawings
  101, 102, 103.... Etc are for components

RCF Drawings:

- First two digits: Code
  CC, LW, AW, YF, VP etc.
- Next two digits : group
  00,01,02,03,04,05,06,07,08 etc.
- Next three digits: Serial No.
  001, 002 for arrangement drawings

101, 102, 103.... Etc are for components

BEML Drawings:

First Three digits indicates series of drawing like 411 , 811
Next number indicates serial number of drawing

DLW drawings:

DLW drawings are generally with PL No and part Nos

System of reading a drawing:

- Drawing to be read from FRONT or RIGHT
- Angle of Projection
- Drawing scale
- BOM
- Alteration/version
- Applicability

Maintenance of drawings:

Drawings are prepared by RDSO, DLW , ICF , RCF & BEML.

Carriage drawings are generally prepared by ICF, RCF &BEML some of the drawing are prepared by RDSO

Wagon drawings are prepared by RDSO

Diesel drawing are prepared by DLW and RDSO

Now a day's ICF and RCF are advising drawings in soft copies. RDSO and DLW are advising drawings in hard copies. In zonal office drawings are maintaining both in soft and hard copies. Hard copies are maintaining in two types, drawings on tracing paper and blue prints as received from PUs and RDSO.

Drawings on tracing paper will be plotted for all stocked items and for different arrangement sub assemblies. Drawings on tracing paper will be used for generating blue prints which will be advised to shops, divisions and stores departments.

Drawings on tracing paper will be kept in the steel /wooden racks designed for keeping the drawings. These racks are designed as per the size of the drawing and drawings are maintained as per size, group and year of preparation, approximately 2,50,000/ drawings are being maintained in zonal office.

Applicability of drawings:

Drawings are being used for carrying out modifications being advised by Pus and RDSO and for procurement of material for POH , IOH and ROH repairs.