



NORTH WESTERN RAILWAY SUPERVISOR'S TRAINING CENTRE, AJMER



COURSE TEXT BOOK MSE/MJR – II (WORKSHOP)

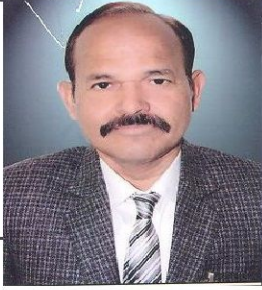


उत्तर पश्चिम रेलवे
North Western Railway



सत्यमेव जयते

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FOREWORD

I am extremely happy to know that STC, Ajmer is publishing this text book which will be useful for newly recruited SSEs and JEs. This book will surely help in imparting required knowledge to improve their awareness on safety and work areas.

This Course Text Book (MSE/MJR- IInd Session) as per prescribed Railway Board Module contains updated common topics of Tender and Contract, Accident and Disaster Management, Supervisory Skill and Stream Specific Theory i.e. C&W, DSL and Workshop in each book separately.

I hope this Text Book will be very beneficial to Mechanical Supervisors. I wish to congratulate the Principal and his team of STC/Ajmer for their Endeavour under the valuable guidance of CWM/Ajmer.


(Virender Kumar)
PCME/NWR

North Western Railway

Sudhir Gupta
Chief Workshop Engineer



Headquarters Office
Jaipur



FOREWORD

As per instructions from Railway Board, study material should be provided to trainees so that they can use it for their study, comparison and reference. STC/Ajmer has taken initiative and it is going to publish a Course Text Book for Mechanical Senior Section Engineers and Junior Engineers for 2nd Session with the objective to provide guidelines for incorporating the technological up-gradation in their field.

I learnt that this Course Text Book contains latest relevant topics as per training module 2011. I am sure that this book will update the knowledge of all induction course training for their respective trades i.e. DSL, C&W and Workshop and common topics for all supervisors i.e. Tender and Contract, accident and disaster management, supervisory skill etc.

I appreciate and congratulate the Principal/STC and his team for sharing their knowledge and bringing the relevant information in the form of Text Book.

(Sudhir Gupta)

आर.के.मूंदडा
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FOREWORD

Mechanical Department is responsible for maintenance of rolling stock including passenger coaches, freight wagons, diesel locomotives, DMUs and cranes. Besides, it maintains large number of machinery & plant in workshops, sheds and other work centers. In this regard STC/AII plays a vital role in imparting qualitative and effective theoretical training to the newly recruited Supervisors to develop their professional aptitude.

I am glad to know that STC/AII is constantly publishing the Course Books on latest developments in some more significant topics of maintenance. In continuation a Course Text Book for MSE/MJR IInd Session is being published as per Railway Board's Training Module. I believe that this Course Book will enhance the Supervisor's theoretical knowledge and should make him a master of his job which will result efficient Train Operation, Maintenance, reduction of line failure and punctuality will improve.

My whole-hearted congratulations to the principal and the team of lecturers for incredible efforts.

(R.K. Moondra)



PROLOGUE

Once again in the series of course books for direct recruited MSE/MJR II Session as per prescribed module of Railway Board with the inspiration of our CWM/AII Shri R.K.Mundra is prepared in the form of book.

You will find that various chapters in this course book have not only been updated, they provide more in depth information, as also touch upon new areas of Railways.

I feel happy in presenting this book. As this book has been receiving excellent reception from the faculty of STC Ajmer S/Shri Umesh Kumar Nema, Mahesh Sharma, B.L. Gupta, Suresh Jharotia, Srikant Yadav, Prakash Kewalramani and Amar Chand Gaharwar as they have deep knowledge of their field.

The complete figure work has been done on Computer. The format of the book has also been changed. For all this and for the excellent getup of the book, I must thank Shri Surendra Tak, Chief typist and Specially Smt. Manisha Khandey, CA as chief coordinator of this edition.

Any errors, omissions and suggestions for the improvement of this book brought to our notice will thankfully be acknowledged and incorporated in the next edition.

Thanks.

(J.P. Sharma)

MODULE AND INDEX

S. No	Description	Page No	
		From	To
1	Tender and Contract (MRT -01)	1	23
2	Accident and Disaster (MRT -0 8)	24	59
3	Supervisor Skill (MRT -09)	60	81
4	Welding and NDT (MRT – 10)	82	113
5	Workshop Theory – (MWT- 01)	114	219

INDEX

TENDER AND CONTRACT

S. No	Description	Page No	
		From	To
1	Estimate	1	5
2	Tenders	6	16
3	Contracts	17	23

ESTIMATES

Introduction

The Execution of work in railways include various stages of processing, starting with the preparation of Abstract Estimate, its concurrence and sanction; preparation of detailed estimate, its concurrence and sanction and finally the tender and the agreement.

Financial concurrence includes the financial viability with respect to the total cost of the work. Concurrence and verification of an estimate is a part of financial function.

Definition

An estimate is a statement prepared to gauge an idea of expenditure to be incurred on a work in order to obtain sanction of competent authority and also to see that work is financially justified.

All proposals for:

- The construction and purchase of new work or asset.
- The renewal and replacement of existing works or assets chargeable to DRF, DF, RSF, SRSF, OLWR, and capital fund when estimated to cost more than Rs. 200000/-.
- The scrapping, dismantling or abandonment of the existing works or assets.
- Repairing or reconditioning if estimated to cost more than Rs. 100000 of the existing works or assets.
- Temporary and experimental works.
- The renewal and replacement on worked lines.
- Renewal of ballast should ordinarily be scrutinized by the authority competent to sanction them before any expenditure of liability is incurred thereon. This scrutiny is exercised through what are called Estimates for the works.

Exception to this Rules/Commencement of work without estimate:

- Works which are considered to be urgently necessary to safeguard life or property or to repair a damage to a line caused by flood, accident or other unforeseen contingencies, so as to restore or to maintain through communications.
- For new minor works costing Rs. 50000 and less; for replacement and renewable chargeable to revenue costing Rs. 200000 and less; for repairs and reconditioning works costing Rs. 100000 and less, for detailed estimate need not be prepared. A rough estimate should be prepared and kept on record.

Different kind of estimates:

Abstract Estimates

These estimates are prepared for the purpose of obtaining the administrative approval of the competent authority to the scheme of work. These estimates should be prepared in such a way that the competent authority may be enabled to form a reasonable accurate idea of the expenditure involved as well as other data sufficient for the purpose of gauging adequately the financial prospects of the proposal. As such, an abstract estimate should contain a brief report and justification for the work, specification and should mention weather funds are required in the current year and to what extent. The cost of work subdivided under main

heads and sub-heads of specific items should be shown, together with allocation of each such item under capital, DRF, DF, RSF, SRSF, OLWR and capital fund.

Administrative approval to a work or scheme should be accorded by the authority competent to do so, after a thorough examination of its necessity, utility and financial prospects.

In regard to works which are specified in the sanctioned budget of a year i.e. in the Works, Machinery and Rolling Stock Programme accompanying the budget orders, the total estimated cost shown against each work should be regarded as the abstract estimates. The inclusion of work in the sanctioned budget should be deemed to carry with it the administrative approval of the railway board except that in the case of structural work, other than track renewal work, costing more than Rs. One Crore each, the administrative approval of the railway board should be obtained by submission of separate Abstract Estimate notwithstanding their specific inclusion in the sanctioned budget; however estimates costing over Rs. 5000000 and upto Rs. 1 Crore will be certified and sanctioned personally by the GM after obtaining FA&CAO's concurrence.

Detailed Estimate:

On receipt of administrative approval to the scheme or project, other than construction of new lines, detailed estimate for various works included in the abstract estimate are to be submitted for **Technical Sanction*** of the competent authority. No work included in the abstract estimate should be commenced till detailed estimate has been sanctioned. Detailed Estimate should be prepared in sufficient degree of detail and should provide for all items of works required. The estimate should show the allocation of heads of accounts and should be accompanied by a report giving full justification for the work, the details of the work to be done and also stating whether or not necessary funds exist for the work in budget. The detailed estimate of an open line work will comprise:-

- Statement showing the details of estimated cost; and
- An outer sheet giving the abstract of cost of work, the report, the financial justification and the allocation.

Technical Sanction

The sanction of the competent authority to the detailed estimate of a work is called 'Technical Sanction'. The authority according technical sanction should satisfy that:

- The details of the scheme as worked out are satisfactory;
- The method proposed for the execution of the work is adequate; and
- The cost has been estimated from reliable data and is reasonably accurate.

Supplementary Estimate:

These are prepared for the items of the work which ought to have been included in the first instance but have not been so included or which it is found later, should be considered as being a part of the original estimate already sanctioned, if it cannot be met out of contingencies. These estimates are to be prepared in the same form and in the same degree of details as the original estimate and will be considered for all purpose as a part of the main estimate.

Revised Estimate:

When during the process of work, it becomes evident that expenditure on the same is likely to exceed the amount of the sanctioned estimate; a revised estimate should invariably be prepared and submitted for the sanction of competent authority. It should be prepared in the same degree of details as the original estimate except that unaffected items may be shown

in lump sum. The revised estimate should accompany a comparative statement showing the excess or saving under each sub-head of account against the latest sanction.

It sometimes happens, however, that the work is in advanced stage of completion and it is likely to be complete by the time Revised Estimate is got out. In such cases, the sanction of the competent authority may be obtained to the incurring the excess expenditure on the work and the excess explained in the Completion Report of work.

Project Abstract Estimate:

This is an abstract estimate for construction of project and should be submitted for approval of Railway Board accompanied by:

- (i) An abstract estimate for the construction of junction arrangements;
- (ii) A narrative report explaining the salient feature and major items of the proposed expenditure under workshop, store buildings, plant and construction etc. ; and
- (iii) Detail estimate of cost of construction under various heads of work classification:
 - a) Preliminary Expenses(1110)
 - b) Land (1120)
 - c) Structural Engineering Works (1132), Tunnels (1151) and 1152 major bridges, (1140 Ballast and permanent ways) (detailed estimate for 1 Km.)
 - d) Equipment
 - e) Rolling Stock(2000)
 - f) General Charges(1180 and 1190)

Construction Estimate:

On the basis of final location survey, detailed estimate for all the works in the project of new line as whole, are prepared. These detailed estimates are collectively known as “Construction Estimate” and should be prepared in sufficient details to enable the work being started straightway. These should also provide for all building and equipment to the standard of working required to meet the requirements of traffic anticipated, during the first year or two after opening the lines. It is the basis on which technical sanction to the various works included in the construction of a project is accorded.

The construction estimate of project should be prepared in form E. 553 prescribed for the purpose. It should be divided into convenient sections In accordance with the following principles.

- a) When, as usually the case, certain works within the limit of a junction station are incidental to the project, these works should form a distinct section.
- b) When a project comprised a ‘main line ’and a ‘branch’ should form at least one distinct section.
- c) When the country traversed by a line is such that it may readily be divided into tracts of distinctive topographical character, the length through each class of country may comprise a section, or a project may be divided into ‘engine runs’ or into lengths suitable for “Construction Division”.
- d) Where there is likelihood of different sections of a project being opened to traffic at different intervals, the estimate for each such section should be kept distinct.
- e) When an estimate for any alternative alignment of importance is included, the estimate for alternative alignment and for the length which it would supersede, if adopted, should each be comprised in a distinct section.

Completion Estimate

A completion estimate is prepared in supersession of a construction estimate as provided in para 1701-E. the Construction or a Project Estimates of works costing over Rs. 1 Crore will have to be closed at the end of one of the first three financial half years after the opening of the line and the completion estimate is prepared. The completion estimate is a stock taking estimate and all works not started on that date are excluded from the scope of work/project and are to be dealt with separately. This will show:

- Amount of sanctioned estimate.
- Actual expenditure of all the works up to the date of the closing of the Construction Estimate.
- Commitments in that date.
- Anticipated further outlay.
- Total estimated cost.
- Difference between the sanctioned estimate and total estimated cost.

An abstract of the completion estimate showing the above particulars against the various heads of capital classification should be submitted to Railway Board together with the brief explanations for the excess of not less than Rs. 25000 or 10 % over the estimated provision under sub-head of accounts and for saving of 20% or Rs. 1 Lakh whichever is less, occurring under any sub-head of accounts.

The completion estimate should reach the Competent Authority within 4 months after the close of the financial half year up to which it shows the actual expenditure. Provision for further outlay on only those works as are in progress on the date of closing of the construction estimate should be included.

The date of opening in the case of new line should be held to be the date of opening for passenger traffic of the whole line included in a Construction Estimate.

If different sections of a project are likely to be opened at intervals exceeding one year, separate completion estimate should be submitted for each section. In the case of open line project, the date of opening should be held to be the date on which the project fulfils the purpose for which it was sanctioned.

Completion Estimate involving material modification or excess over estimate beyond the power of the GM should be submitted to Railway Board for sanction. Those which do not involving such modification or excess should be submitted to Competent Authority for sanction, normally GM of Zonal Railway and the Railway Board being informed.

Points to be taken into consideration while preparing and checking estimates:

- A. **Proprietary of Expenditure.** The accounts officer in his capacity as Financial Advisor has to Examine all proposals for expenditure with a view to see:
- a) That the expenditure proposed to be charged to Railway Funds in the estimate is properly and legitimately so chargeable;
 - b) That proper financial justification is forthcoming in the case of all works requiring such financial justification and they are absolutely necessary and cannot be avoided or postponed; and
 - c) That in the case of estimate for staff quarters and other rent-returning buildings the anticipated yield of rent as shown in the rent statements will have the effect of reducing the return on the cost (excluding land) of each class of quarters to less than 6% per annum.

- B. Incidence and Classification of Charges.** Incidence and classification provided in the estimate should be verified with the reference to the extent provision in Financial Code and a specific certificate of verification should be recorded by Accounts Officer. Submission of an estimate to the sanctioning authority should not be delayed when there arises any doubt as to the correct allocation of estimated cost. In such cases, approximate allocation between Capital, DRF, DF, RSF, SRSF, OLWR and Capital Fund should be certified by Accounts Officer, as far as it is possible for him to do so, and the sanctioning authority may sanction the estimate, if otherwise in order, leaving over the question of allocation for subsequent consideration.
- C. Budget Provision.** The existence of budget provision for the proposed work should be verified from the sanctioned allotments for the year, it should be ensured that such certificate is recorded in the estimate.
- D. Competency of Sanction.** The Competent Authority who has to sanction the estimate has to be indicated and is verified. The verification should be done in accordance with para 748E and delegation of powers as well as the powers re-delegated by the GM to the lower Authorities.
- E. Freedom from Errors and Omission.** Errors and omission noted during the course of Accounts verification of the estimate should be got corrected by the executives responsible for preparation of estimates.
- F. Subsidiary Points.** In the check of estimates the following subsidiary points should be checked to see:
- That the particulars of work are given in sufficient details ;
 - That a proper distribution is made of the estimated outlay between Cash and Stores;
 - That the allocation of each item is given and that an abstract allocation is made;
 - That the reason or necessity of undertaking work is furnished;
 - That all incidental expenditure that can be foreseen has been provided for;
 - That in case of renewal, replacement and dismantlement credit for released materials has been provided for;
 - That in case of rent-returning buildings and staff quarters, a rent statement accompanies the estimate;
 - That in case of estimate for manufacturing operation the outlay and outturn are distinctly shown;
 - That in case of work undertaken for private bodies and other Government Departments provision has been made for necessary department charges and the amount is deposited or acceptance obtained as required under the rules; and
 - That the provisions of paras 732 E to 735 E and 1137 E to 1140 E etc. have been kept in view while framing estimates of deposit works and works for other Government Departments.

TENDERS

Main Steps of Procurement

1. Preparation of Demand
2. Approval of competent authority
3. Vetting from Accounts.
4. Budgeting.
5. Issue of Tender.
6. Receipt of Tender and Opening.
7. Brief note and comparative statement.
8. Rates reasonability and technical suitability.
9. Issue of Purchase order.
10. Inspection.
11. Receipt of Material.
12. Verification of bill.
13. Warranty Certificate.
14. Return of Security Deposit.
15. Performance certificate.

Definition:

The Tender is a notice to all business concerns to enable them to give quotations for supply of stores as well as for execution of engineering works. Such notice in case of large - works should not be less than one month and for other works should not be less than 14 days.

In order to obtain the cheapest, economic and competitive rates tender system is adopted. Therefore, while adopting this effective method very careful and serious consideration shall be made.

As per practice in vogue on Railways, such notice should be given in leading newspapers i.e. two English and one in Regional language for big works and for small works one in Regional language. Publicity should also be given at Railway stations and offices, other divisions apart from the division from where invitation of tender is sponsored.

Once it is decided to, execute the work through the agency of contractor by calling tenders, the following, conditions should be fulfilled:-

- a) That the Railway is in a position to handover the site of work and plan to the contractor
- b) That the Railway should be ready with full knowledge of character and scope of work.
- c) The Railway is ready with design of work, detailed drawings, and schedule of quantities.
- d) Soil exploration should have been carried, out at sites which are located on filled up tanks or hollow ground so as to avoid any changes in the design of foundation and structures at a later date;
- e) That tender documents for sale will be ready from the date notified.

The tender forms supplied to intending tenders on the payment of specified amount should specify:

- The amount of Earnest Money to accompany the tenders and the nature of Security Deposit, if any, required in case of accepted tender.
- The place where the Earnest Money is to be deposited.
- The place and time where the blank tender forms can be obtained and the contract documents can be seen.

- The date time and place of opening of tenders.
- The nature of work to be executed and approximate value of tender.
- With whom or what authority the acceptance of tender will rest.
- Whether or not tenders containing erasures and alterations of tender documents will be considered.
- The amount to be paid for tender documents.

Kinds of Tenders:

- (a) Open Tender,
- (b) Limited Tender,
- (c) Single Tender, and
- (d) Global Tender.

These are explained as under:

Open Tender

This system of invitation of tenders by public advertisement in the most open and public manner possible, should be used as a general rule and must be adopted in all cases in which the estimated value of tender to be received is Rs. 25,000 and over subjected to certain exceptions (limited tenders, single tender or dispensing with tenders).

In regard to Stores department this system is adopted in the same manner subject to the exceptions given in paras 331S and 332S in normal circumstances in which the estimated value of the Tenders to be received is Rs. 3 lakhs and over and over Rs. 25 lakhs in emergencies.

Limited Tender

In case of Stores department, except in the case of safety items, this system may ordinarily be adopted when it is considered to be advantageous, in case of orders the estimated value of which is less than Rs. 3 lakhs. In case of safety items, this system may be adopted in case of purchases, the estimated value of which does not exceed Rs.1 crore. Where for reasons which should be in public, interest, it is considered not possible to call for open tender, limited tender may be invited with the concurrence of Financial-Adviser, and approval of competent authority. The reasons for inviting limited tenders from the firms/contractors should be kept on record while approaching Finance for concurrence.

The procedure for inviting limited tender has been approved as a regular measure and works up to a limit of Rs. 1Crore can be awarded on limited tender basis. This will also apply to construction projects. Finance concurrence is not necessary in case contractors are borne on the approved list. However, if the limited tenders are proposed to be invited from the contractors not borne on the approved list, prior financial concurrence will be necessary. Same procedure shall apply even if one of the contractor is outside of the approved list only. Limited tender should be invited from the contractors borne on the approved list only.

Single Tender

Calling of single, tender for works should be resorted to only in exceptional circumstance after recording necessary certificates:

- (a) The certificate with proper justification should be given that it is not in the public interest to call for tender by advertisement.

- (b) It should be certified that the demand is so urgent that any saving likely to be achieved by elimination of the open competition must be ignored.
- (c) Certify that the work is of such a nature that there is no other suitable agency/contractor to execute the work.
- (d) The reasons as to why single tender is being resorted to in preference to limited tender.
- (e) The proposal must have prior financial concurrence and personal sanction of General Manager except when the power has already been redeligated.
- (f) In case of ST, Tender Committee and the accepting authority should be one step higher than in case of Open Tender/LT for works.

Global Tender

This system is adopted by Railway Board or the Government of India for purchases throughout the world. For this type of tenders the General Managers of Zonal Railways and the Administration under them have no powers.

List of Approved Contractors:

No work or supply should ordinarily be entrusted for execution to a contractor whose capability and financial status has not been investigated beforehand and found satisfactory. For this purpose a list of approved contractors is to be maintained in the Headquarters and the Divisional offices of a Railway.

1. Limited Tender should be invited from the contractors borne on the approved list only. Notice for inviting Limited Tenders shall be published in local newspapers and displayed on the Notice Boards kept in the concerned Railway Office and also put on the internet wherever possible. It will be the duty of the prospective tenderer to keep track of the tender notices issued through any one of these media.
2. Individual Railways may decide the "category of works" for which list of approved contractors should be maintained for each monetary slab.
3. The Approved List will be in Four monetary slabs only as below :
 - Class 'D' - up to Rs. 10 lakhs.
 - Class 'C' - More than Rs. 10 lakhs and upto Rs. 25 lakhs.
 - Class 'B' - More than Rs. 25 lakhs and upto Rs. 50 lakhs.
 - Class 'A' - More than Rs. 50 lakhs and up to Rs. 1 crore.
4. The Approved List will be valid for 3 year.
5. The list will be reviewed every year for deletion which will be effective from 1st July and additions, if any, will be done once in 6 months and which will be effective from 1st January and 1st July.
6. Once the contractor is borne on the Approved List, it will be valid for 3 years, unless already deleted during the Annual Review, or the expiry of the validity of the "Approved List" as-a whole, whichever is earlier.
7. There will be separate Approved Lists for Open Line and Construction Organizations for each identified category of work.

8. In Open Line, Approved List for classes 'B', 'C', and 'D' will be maintained Division wise and for Class 'A', there will be one common list for the Railway as a whole. In Construction Organization, Approved List for Classes `B', 'C' and 'D', Will be for a particular pre-determined geographical area or Dy. C.E.(Con.)- wise and for Class 'A', it will be CAO(C)/GM(C)-wise.
9. Selection of contractors for enlistment in the Approved List should be done by a Committee to be nominated by the authority not below the Accepting Authority as given below. The composition of the Committee will be as follows:

Class of Contractors	Select committee Composition	Accepting Authority
Class 'A'	One SAG Officer each of executive Department and PHOD finance Department	Executive Department PHOD
Class 'B' and 'C'	One JAG Officer each of Executive Department & Finance Department	DRM in the Division/ SAG Officer of the Executive Department
Class 'D'	One Senior Scale Officer each of Executive Department and Finance Department	Sr. DEN (Coordination) in Division and Dy. CE (Construction) in Construction.

Note: Normally, in Construction, no contract below Rs. 10 lakhs value should be called.

10. For registration in Approved List, the contractor will have to furnish a non-refundable fee of Rs. 5,000 for Class 'D', Rs. 7,500 for Class, 'C', Rs. 10,000 for Class 'B' and Rs. 15,000 for class 'A'. This fee will cover the entire period of 3 years or part thereof. Contractors desirous of registration should submit the application in the proforma prescribed by the Railway with the prescribed fee for each 'category of work' in each slab.

For considering enrolment of contractors in the various categories, the following criteria may be followed:

(a) Class 'A'

- They should have a permanent Engineering Organization with at least a graduate engineer having 10 years' experience plus an engineering diploma holder having 5 years' experience and should maintain a minimum complement of transport equipment, construction tools and plants required for the works.
- At the time of enlistment, they should have satisfactorily executed at least two works, each individually costing not less than Rs. 25lakhs.

(b) Class 'B'

- They should have a permanent Engineering Organization with at least a graduate engineer having 5 years' experience and should maintain a minimum complement of transport equipment, construction, tools and plants required for the works.
- At the time of enlistment, they should have satisfactorily executed atleast two works, each individually costing not less than Rs. 10 lakhs.

(c) Class 'C'

- They should have an Engineering Organization with an engineering diploma holder having at least three years experience.
- At the time of enlistment, they should have satisfactorily executed atleast two works, each individually costing not less than Rs. Five lakhs.

(d) Class 'D'

At the time of enlistment, they should have satisfactorily executed at least two works, each individually, costing not less than Rs. 1 lakh.

Tenders for Zonal works and Supply of Materials:

The zonal tenders are mainly intended for doing the usual repairs and maintenance works like white washing, painting, re-roofing, re-flooring and repairs to drains and road and sanctioned work up to Rs. 2 lakh at a time and also for supply of materials like Bamboos, sand, moorum, ballast, cost of any item not exceeding Rs. 10,000 At a time during the currency of contract for particular zone. It is often advantageous to allot all works of repairs and maintenance, special works and supply of materials in a particular zone to zonal contractor's separately for each of the above category and during the currency, care should be taken that work order in excess of Rs. 2lakh for repair and maintenance works and Rs. 10,000 in case of supply at a time should not be issued.

Time lag for Supplying Closing and Opening of Tenders

The following are instructions in order to adopt uniform procedure which should be followed in respect of all tenders:

- a) Time lag, between the cessations of sale of tenders and closing time for submitting the tenders should be four hours.
- b) Time lag between closing time for submission of tenders and opening of tender's box should be five minutes.
 - i. It will be up to contractors to obtain tender papers by post or in person, in time. The, sale/issue, of tender papers may therefore continue unabated up to the time notified for closing the sale/ issue of tender papers irrespective of any consideration whether the tender papers are required to be sent by post or issued in person to a contractor.
 - ii. Under no circumstances tender papers should be issued after the time notified in the tender notice or the cessations closing the sale of tender papers
 - iii. If the time and date for submission of tender is to be extended on accounts of any reason this should be done well in advance giving necessary notification and also advising all tenders those who have purchased the tender papers. Once the sale of tender is ceased, closing time should not be extended thereafter under any circumstances.

- iv. in case it is found not feasible to open the tender box within 5 minutes of the time notified, for closing the submission of the tenders, a slip duly signed by an Officer preferably Sr. Scale Officer of the convening department should be pasted on the tender box to prevent further deposition of tenders.

Opening of tender:

Sealed tenders are deposited by the tenderers in a sealed box kept for this purpose at the advertised place. This box is sealed duly signed by the accounts representatives if available at the advertised place. Opening of tenders is done by the tender opening committee consisting of an executive officer and accounts representative in the presence of tenderers. It should be seen that the earnest money is deposited in the proper form and if the same is not in order, the tender of such tenderers should be rejected as per the conditions in the tender form and the rates are read out. The tender form are checked mainly with reference to the rates of non-stock items, percentage of M.S items, completion period, validity period of tender and any other conditions quoted anywhere in the tender form. These all particulars are initialed by both representatives. Each department which deals with tenders should maintain tender registers. The register is to be signed by all tender opening members as well as by the contractors. The tenderer shall be required to deposit the earnest money, which is 2% of estimated value.

Delayed tender:

It is the tender which is received after appropriate time but before opening of tenders by the tender opening committee and this tender is acceptable and dealt with in the same manner as in the case of tenders received in time.

Late tenders

It is a tender which is received after the opening of tenders. It should be prominently marked in Red ink and also on the cover by the tender opening committee and although unacceptable, the rate of such tender could be read out. These tenders should not be accepted. However, such late tenders can be accepted by the GM with the concurrence of FA&CAO in exceptional circumstances.

Evaluation of tenders and briefing notes

Executive officer after evaluating each tender viz.

- a. Par value
- b. MS items and percentage
- c. Value of NS items. Verified by the section officer{accounts} along with his briefing notes should send original tenders to the accounts department for the finalization of tender by duly constituted committee as per extent rules.

The comparative statement of rates, amounts, and quantities etc. for the consideration of tenders should be prepared by the departmental office from where the tenders are invited and checked in the account office. Each and every page of the comparative statement should be signed by the staff preparing it and also by the officer checking the same.

While making briefing notes the following specific points should be commented upon:

- (a) The position with regard to the previously accepted rates.
- (b) Remarks vis-à-vis the special conditions stipulated by the tenderer, if any.

- (c) Any lacuna or omissions coming to the notice of the section preparing the briefing notes.
- (d) The experience, capability and the financial status of the contractors either new or already working with the railways in such case details are available or obtained from contractors.
- (e) The basis for arriving at the all-in-one cost of the tender and their respective positions such as lowest, second lowest etc.
- (f) Any other points which may be considered of interest to the tender committee for dealing with a particular tender.

Scrutiny in accounts:

- a) That a briefing note has been received together with a copy of all comparative statements indicating all-inclusive cost duly checked by the section officer (Accounts) of Finance section. In the case of uneven and unusual conditions the tenders have to be brought at par for correct evaluation;
- b) That in every respect of the advertised tenders, there has been proper publicity in the local newspapers with adequate notice;
- c) That in respect of limited tenders, whether there has been sanction of the competent authority and tenders have been issued to all firms on the approved list.
- d) That the purchase being made is covered by a proper demand in the form of a requisition/estimate sheet duly vetted by the workshop accounts officer at the appropriate level for all the demands exceeding 25000;
- e) That the item proposed is a Workshop manufacture item or not and in the case of former, why is this being off-loaded to trade.
- f) That the offers received in response to tenders are attested by the Accounts representative at the time of opening of the tenders.
- g) That the item proposed for purchase should not appear in the latest computer overstock statements or as non-moving items.
- h) That the proposed rate for acceptance should invariably be the lowest.
- i) That in the case of request for advance payments ranging from 90% onwards, whether the firms are of repute and their past performances justify the acceptance of the term of payment of such advances on such inspection.
- j) That in the case of purchases involving foreign exchange, whether the items are not indigenously available and there is proper clearance for importing such items;
- k) That in the case of single tenders, whether the indent is covered by the issue of a PAC signed by an Officer at the appropriate level.
- l) That the tenders should not contain unusual conditions relating to the delivery terms, warranty etc. and if so whether the same will affect the interest of Railway Administration adversely;
- m) Whether the lowest offer/offers are bypassed in consideration of the earlier delivery date;
- n) That the conditions of earnest money deposits/ITCs etc are fulfilled and the firm is not blacklisted/suspended or removed from the approved list of suppliers;

- o) In case of works all the above points are to be seen. The calculation of M.S.N.G items, the percentage above/below/par MS items to be checked;
- p) The special conditions of contracts are commented upon.

Tender Committee

As an adhoc Tender Committee of not less than 3 members (for tenders costing above Rs.10, 000 and above) shall be constituted by the authority competent to accept the tenders for the purpose of considering the tenders. One of the members shall be nominated by the FA&CAO. One member of the executive department doing the same type of work.

Railway have decided that the work contracts up to the value of Rs.10 lakhs , the tender committee may hereafter be constituted consisting of a minimum of 2 members only and in case of works above 10 lakhs Tender Committee shall have 3 members.

The tender accepting committee should be independent of the tender committee and should not work as a member of the Tender Committee. Otherwise the recommendations of the Tender Committee should be put up for acceptance to the next higher authority.

S. No	Value limit of the tender	Accepted by	Stores	Consum. Deptt.	Finance
1.	Rs.45 lakhs to Rs. 01 Cr	JAG	Sr. Scale	Sr. Scale	Jr. Scale
2.	Rs. 01 Cr to 05 Crs	SAG	JAG	JAG	Sr.Scale
3.	Rs. 05 Crs to Rs. 200 Crs	SAG	SAG	SAG	JAG
4.	Rs. 200 Crs to Rs. 500 Crs	AGM	PCMM	PHOD	PHOD
5.	Above Rs. 500 Crs	GM	PCMM	PHOD	PHOD

In all tender cases, recommendation of the Tender Committee (TC) should be put up to the next higher authority for acceptance. The practice of putting up the TC'S recommendation to a colleague of the same grade level is in gross violation to the instructions issued by the Board's vide letter no. 2004/CEI/CT/13dated 24.8.2004.

Constitution of Tender Committee for execution of works:

The constitution of the Tender Committees for considering the tender and power of acceptance of tenders for executing works, Railway Board have left to Zonal Railways, for formation of Tender Committee and power of acceptance of tenders in consultation with FA&CAO. Therefore each zonal railway has to finalize the constitution of tender committees at various levels and powers for the acceptance of tenders.

Undertaking by the member of tender committee:

Members of the tender committee should give undertaking at the appropriate time, that none of them has any personal interest in the companies / agencies participating in the tender process.

Disposal of tenders:

The target dates have been fixed for disposal of tenders that is from the date of opening of tenders till the date of finalization of tenders/ negotiations.

S. No.	Items	T.C. to be held on division	T.C. to be held at headquarter
1.	Opening	D	D
2.	Notes of Headquarters	---	D+5
3.	Notes to FA&CAO/ DAO	D+5	D+9
4.	Tender committee meeting	D+15	D+15
5.	Tender committee proceedings at headquarters	D+15	---
6.	Tender committee proceedings put upto competent authority (in case negotiations is required)	D+17	D+17
7.	Case to GM for sanction of negotiations	D+18	D+18
8.	Receipt of GM's sanction	D+21	D+21
9.	Negotiated tender invited	D+23	D+23
10.	Negotiated tender considered by the tender committee	D+31	D+31
11.	Negotiated tender received	D+31	D+31
12.	Negotiated tender proceedings put upto competent authority	D+33	D+33

In the case of complicated tenders containing a number of special conditions etc. such as steel work tenders, four more days will be allowed for the preparation of notes and sending to FA&CAO/DAO/Headquarter. In such cases all the dates will be put back by four days.

The agreement for execution of work or purchase order eventually issued should be checked by Section Officer(Accounts) attached to Executive Officer or by the Section Officer(A) of finance branch of accounts department if tenders are finalized at Headquarter level.

Points to be seen by Tender Committee for Finalization of Tenders

The following main points are to be seen by the Tender Committee while finalizing tenders-

- The type of publicity given.
- Number of tenders sold and returned.
- Sanction to the work and detailed estimate.
- Provision made in the estimate for the items included in the tender schedule.
- Earnest money paid in proper form and the proof thereof.
- Validity period of offer is current.
- A comparison of tender value and all in cost as per accepted tender with the estimated provision.
- Reasonableness of rates i.e. %, N.S items quoted by tenderers with reference to last trade accepted for similar work.
- Completion period should be commented upon.

- If a late or delayed tender is to be accepted, it should be seen that sanction of competent authority exists for doing so.
- For inclusion of NS items rates analysis should be made out on the basis of M.S. items and accounts concurrence obtained.
- Recommendation of tenders whether:
 - (a) Accepted lowest tender ,
 - (b) Bypassed lowest tender, or
 - (c) Negotiations and reasons therefore.
- In case of tender for supply of materials where samples are required to be submitted alone with the tenders, the samples shall be tested and tender committee's proceedings should contain the specific comments on the samples.

Role of Tender Committee Members: The tender committee consists of:

- A technical member, who is normally known as convenor.
- A finance member, a person from associate finance.
- A third member drawn from any other technical department.

The Role of Convenor:

- (a) The convenor has normally full knowledge of work to be executed, all special features, site conditions, specifications of the work, credentials of the tenderers, time frame, urgency etc.
- (b) Market survey for the rate analysis and Implications of special conditions, if any, are also to be evaluated by the convenor.
- (c) The convenor must fully brief the tender committee.

The Role of Finance Member:

Finance Member must ensure that all tenderers have fulfilled the prerequisite conditions, i.e.

- (a) Tenders are in properly issued form.
- (b) Tenders are signed by authorized persons.
- (c) Tenders have been opened correctly.
- (d) Earnest money is requisite and in acceptable form.
- (e) All valid tender offers are serially placed and put up in a comparative statement along with a briefing note, dully vetted.
- (f) The arithmetic accuracy of the offer.
- (g) The funds position and if work is sanctioned.
- (h) All special conditions having financial repercussion have been examined.

The Role of Third Member:

The third member must ensure that rules are followed in general i.e.:

- (a) Reasonableness of rates have been properly examined.
- (b) A uniform and consistent approach has been adopted in dealing with the tenders.

Responsibility of TC as a whole:

It is collective responsibility of the tender committee to give definite recommendations with full facts and reasons bringing out all the known facts, background, valid apprehensions which have formed the basis for its recommendations.

Role of Tender Accepting Authority:

TAA, while considering the TC proceedings, should examine whether

- (a) Work is essentially required and is covered by sanctions and funds are available.
- (b) In case of open tenders, full opportunity has been given to all the tenderers.

- (c) Response has been adequate, i.e. no. of tenders sold vis-à-vis no. of offers received.
- (d) Reasonableness of offers has been properly examined by the tender committee.

Rejection of Tenders

It is within the competence of accepting authority to reject the tenders recording his reasons for such action but the accounts concurrence should be obtained in all such cases except where TC has recommended rejection.

Negotiations

Calling for negotiations: it should be clearly understood that selection of contractors by negotiation is an exception rather than the rule and may be resorted to:

- (a) Where all the tenders are considered to be unreasonably high in value and it is felt that retendering would not serve any better advantage to the railway; and/or
- (b) Where the lowest tender is technically unacceptable or is rejected because of unsatisfactory credential, capacity or unworkable rates
- (c) Where in the case of proprietary items of stores, the price quoted is considered to be unreasonably high.

Restrictions

- (a) Competent authority after receiving recommendations of T.C. should decide with whom to negotiate.
- (b) In no case negotiations should be extended to tenderers who had either not tendered originally or whose tenders were rejected because of unsatisfactory credentials, capacity or unworkable rates.
- (c) The above instructions may not be applied rigidly to tenders for specialized works and equipments where the tenderers may quote accordingly to their own specifications and design for various reasons such as improvements to technology.
- (d) Procedure for conducting negotiations should be decided on the merit of each case in consultations with FA&CAO.

Tenders can be dispensed with:

- (a) General Manager may dispense with tender procedure in the public interest, upto Rs.25000 in value when it is not practicable or advantageous to call for tenders.
- (b) For works based on schedule of rates the General Manager may decide not to call for tenders upto a value of Rs50000 without recording reasons.
- (c) In all other cases when General Manager decides not to call for tenders the reasons should be recorded and financial concurrence obtained.
- (d) Works which are considered to be urgently necessary to safeguard life or property or repairs, damaged to the line caused by flood, accidents so as to restore and maintain through communications.

Solitary Tender:

In response to open tenders, the only one tender returned is called solitary tenders. This tender can be accepted under the normal rules.

CONTRACTS

Definition

Under Indian contract act 1872, when two or more persons have a common intension communicated to each other to create some obligation between them it is said to be an agreement. Such agreements which are enforceable by law are known as contract. Only those agreements are enforceable by law which are made by free consent of parties.,

Free consent of parties: An unqualified acceptance of a tender constitute a binding contract until a final agreement is constituted and in order to ensure this fact the acceptance letter should be suitably worded. However if the acceptance of tender by railway is a conditional acceptance, It requires the consent of tender before binding contract takes place.

Authority competent to contract (railway side):for entering into any contract, the approval/acceptance of authority is necessary who is competent to accept as delegate under SOP by railway board to GM annexure II to chapter 5 of financial code and further by GM to subordinate authority. The contracts are signed by authorities competent to sign under SOP, on the behalf of president of India and attested by witness.

Competent authority to contract on contractor side

- (1) in case of partnership the person, who is authorized by partnership deed
- (2) in case of company, the MD who is authorized by a resolution or by article of association, and
- (3) in case sole proprietor, proprietor himself or the person to whom power of attorney is given

The above aspects should be decided only after taking legal opinion on the contractor document from law officer and for such opinion a fee of RS. 50 per case is to be charged from contractor

Lawful consideration for a contract to be legal, there must be a lawful consideration for performance. Such consideration may take a positive form or negative form. Such an agreement to order a certain quantity of work or material. An agreement not to order certain work or material from anyone but the contractor. The negative form of consideration may be advantageously being employed in case of:

- Supply of material of perishable nature.
- Material which are not necessary to stores.
- Requirement which is not possible to estimate, and
- Where a contractor offers to carry out all work on a division at a fixed percentage below the schedule of rates (para 422S)

Forms of contract

There are following forms of contract.

Work contracts:

- (i) **Lump sum contract:** lump sum contract is a contract under which the contractor engages to carry out a work or effect supply as specified and within a given period for

a fixed total sum, and time, irrespective of actual quantities and kind of work done. His receipt of sum being dependent on his completing the work to the specification in the time.

- (ii) **Schedule contract:** in this contract the contractor engages to carry out a work or effect supply as specified within a given period, at fixed unit rates for each of the various items comprising such work or supply. The sum he is to receive depends on the actual quantities and kind of work done or supply made to specification and time
- (iii) **Piece work contract:** Piece work contract is contract under which only unit rates are fixed for various kinds of work or material are agreed upon, without reference either to total quantities of work to be done or material supplied or to the quantity of the work to be done or material supplied within a given periods.(zonal contract fall under this category).

(b) Stores Contract:

- (i) **Rate contract:** Rate contract is a contract under which only during the period of its currency, the contractor engages to supply materials on demand, irrespective of quantity, at fixed unit rates within given period of the receipt of such demand (Rate contract is purely a rate agreement with certain stock obligation on the part of the rate contract holder)
- (ii) **Running contract:** it is a contract under which during the period of its currency, the contractor engages to supply and other party to the contract to take a specified quantity with a percentage tolerance of material as and when ordered, at fixed unit rate within a given period of the receipt of such order.(it is a guarantee that 75% of the quantity covered by the running contract will be drawn during the currency of the contract with an option up to 125% of the quantity covered by the running contract)

Works contracts:

All works and supplies relating to works executed through the agency of contractor are classed as under-

- (a) **Zonal works:** The works of ordinary repair/maintenance and other petty nature in a particular zone such as white washing, reroofing, re-flooring, repairs to roads and drains.
- (b) **Special works or construction works:** construction of bridges, foundation an embankment and other than zone work.
- (c) **Supply of building material:** for supply of all building materials such as bricks, tiles, lime, bamboos, ballies, matting.

It is often advantageous to allot all minor works and all works of repairs and maintenance in a particular zone, for a define period, to one contractor. It may be likewise advantageous to make this contractor who can be called a zonal contractor responsible for the conveyance or supply of engineering materials as and when required in a particular zone during a specified period. The executive officer should take steps to select suitable contractor for zone contracts which shall include:

- (a) New works, addition and alterations to existing structures, special repair works and supply of building materials subject to contract value of each such work not exceeding two lakh.
- (b) All ordinary repair and maintenance works and,
- (c) Conveyance of materials e.g. bricks, lime, sand etc. which are likely to be required in a zone during the year.

Contract Documents

- i. The contract documents are important tools of project management. These documents play a pivotal role in determining scope, time, cost, quality, risk apportionment, communication and matter related to human resource development in the contract. The main documents are the standard & special conditions of contract, the specifications, drawings, the schedule of items, quantities and rates, the agreement form, instructions to the tenderers and the tender forms etc.
- ii. All contract documents exist as a crucial part of risk mitigation, the scope definition and the project communication to all the parties. They should not contain any material that does not apply to the work. They should be prepared in a timely manner and should set the appropriate quality level.
- iii. Normally, the contractor should be supplied with the complete documents. These should be ready at the stage of inviting tenders. That means the drawings and the specifications, should be final and fully coordinated before inviting the tender.
- iv. Aim should be to accomplish dispute free completion of the work. The documents should be clearly understood by all the parties involved. The pre-bid conference should be utilized for ironing out any differences in understanding the content of the contract documents. The standard forms and formats should be used, which keep on getting improved with the experience.
- v. A document prepared by the Federation of International Consulting Engineers (FIFIC) has gained wide popularity in International Competitive Bidding and is considered a model, which can be used in many situations. Some of the projects are receiving external aid and assistance. The funding agencies insist on following the FIDIC or other conditions for contract management to ensure equality and fair play. The parties involved in such projects have to study these documents thoroughly before the bidding.

Specifications and Drawings

The specifications address the project quality and the processes. The drawings define the scope and quantity of work. The standard conditions establish the general rules specially the risk allocation. The execution of works and the supply of materials on contract should be according to the standard specifications and drawings. The specifications could be IRS, BIS or other international standards. If no standard specification exists for any item of work or the supply, complete specification for the same should be prepared by the executive and attached to the tender forms. The drawings wherever required should be prepared, showing the general dimensions and details. These drawings should be made available for reference by the intending tenderers.

If there is a likelihood of some minor changes in the tender drawings, a clause may be added in the tender conditions that the tender drawings are for guidance and not for the actual execution.

Tender Forms

The tender forms should completely embody either directly or by reference the content of the contract documents such as the schedule of quantities, unit rates, the general conditions/ the special conditions of contract, completion period, site details etc. The tender forms should also state:

- i. The amount of earnest money to accompany the tender and security deposit, if any (in case of accepted tenders.)
- ii. Whether or not tenders containing erasures and alterations of the tender document will be considered.

Such alterations constitute fresh proposals and cannot be disregarded but must definitely be accepted or rejected.

Agreement Form

After tenders are finalized, all the elements; schedule of quantities, rates, conditions etc. are put together as agreement form. The agreement form may be tender form itself. The conditions of contract, specifications etc. are embodied/ annexed to the tender form itself. They are readily accessible to contractor for reference. On behalf of the contractor the signature of only such persons/ or person as are competent to bind him legally shall be accepted on the agreement form. Adequate copies of the agreement are prepared and given to the section engineer, ADEN and account's officers.

Rates, Quantities, Nomenclature

All the rates should be entered in the agreement in words as well as the figures. What items are covered in the quoted rates should be clearly specified in the conditions and the specifications. Quantities and units of the measurements are entered in the tender schedule. Regarding the nomenclature, as far as practicable the standard forms of nomenclature or the description should be used. The terminology should be such as to show without ambiguity or doubt, what exactly is required.

The engineering department is having a 'Master Schedule of Rates' and the 'Standard Specification'. This facilitates preparation of the tender schedule. Every time new items, basic rates etc. are not required to be prepared. Electrical, S&T and other department should also prepare 'Master Schedule of Rates' and the 'Standard Specifications'.

Conditions of Contract

Rates and specifications are qualified by the conditions of contract. These can be standard, general conditions or special conditions.

General principles to be followed to enter in to contract

The general principles to be followed to entering into contracts are as under:

- (a) The term of contracts must be precise and definite and there should be no room for ambiguity or misconstruction and the matters to be agreed upon should include in details the following:
 - What contractor is to do, when, where and to whose satisfaction it is to be done.
 - What payment is to be made, what is it to cover, to whom it is to be made, and the method and the basis.
 - What the railway administration is to do and on what terms.
 - The responsibilities of contractor in respect of adequate supervision care of government property, and the protection of outside interest and those of the staff and workmen.
 - The methods of setting disputes.

- (b) As far as possible, legal and financial advice should be taken in drafting contracts before finalization.
- (c) Standard form of contract should be adopted wherever possible, the terms to be subjected to adequate security.
- (d) The term of contract once entered into should not be materially varied except in consultation with the competent legal and financial authority.
- (e) Provision must be made in contract for safeguarding govt properties entrusted to contractor.
- (f) In long term contracts provision must be made for desirability of preserving for Railway Administration unconditional power to cancel the contract at any time after expiry of six months' notice to the effect.

Form of agreement with contractors for execution of work/supply

The following terms of agreements are to be used to execute agreements with contractor, for the execution of work and supply to be made.

Form A: This standard form is utilized for agreement to be executed for work and supply when costing Rs. 10,000 and above.

Form B: This standard form is utilized for agreement to be executed for works and supply when cost is more than Rs 5000 and up to Rs 10,000.

Form C: This standard form is utilized for agreement to be executed for a zone for works and supplies.

Rate Slip: For all works and supply costing below Rs 5000 a rate slip should accompany with work order based on limited quotations which should not be less than three.

Results of execution of work and supply made by contractor

- Either work/supply completed satisfactorily, or
- Contractor failed to carry out the work completely, or
- Contractor failed to carry out the work during the current period of contract, or
- There is dispute/disagreement/difference between the Railway Administration and the contractor.

Work/Supply completed satisfactorily:

If the work/supply are completed satisfactorily by contractor and unqualified no claim certificate is give in the measurement book as well as on contractor's bill, his final bill should be passed and security deposits/retention money should be paid to him. a certain amount can also be kept for recovering possible losses, in case maintenance period is not over.

The guidelines regarding refund of retention money have been given in railway board letter no 59/AC/III/28/5. Dated 18/5/1960 where in it has been decided that it is for Railway Administration. To determine on the merit of each case, what potion of security deposit need continue to be held by railway to cover possible loss due to contractor failure therefore the following decisions has been made to refund the security deposit(on the basis of guideline railway board letter no 59/AC/III/28/5. Dated 18/5/1960).

- a. The amount of earnest money converted into initial security should be retained till all the work order against the sectional contract are completed and the maintenance period of all such work order where prescribed are also over
- b. Where tender are accepted against standing earnest money and contractor instead of depositing the initial security separately request for the collection of such amount by way of 10% deduction through on account bill, an amount equal to initial earnest should be retained out of the retention money, till the final completion of all work order and the expiry of maintenance period

Contractor failed to carry out the work completely

When the contractor fails to carry out the work, the engineer on the behalf of the railway may serve with a notice under clause no. 62 of GCC, in writing to that effect and if the contractor does not within 7 days after the delivery to him of such notice, proceed to make good his fault in so far as the same is capable of being made good and carry on the work or comply with such directions as aforesaid to the entire satisfaction of the engineer, the railway shall be entitled after giving him 48 hours' notice in writing under the hand of engineer, the contract as whole or in part or parts and adopt either or both of the following courses

- i. To carry out whole or part of work from which the contractor has been removed by employment of the required labour and material and the cost of which shall include lead, lift, freight, supervision or all incidental charges.
- ii. To measure up the whole or part of the work from which the contractor has been removed and to get it completed by another contractor, the manner in which such work is completed shall be at the entire discretion of the engineer whose decision shall be final.

Contractor failed to carry out the work during the period of currency of contract

Completion period is always given in the contract agreement, if the contractor could not complete the work during the prescribed period than such cases should be dealt with as under

- i. In case the contractor could not complete work due to fault of railway i.e. late handing over site or the late supply of material by railway and so on, then extension of time limit should be given without levy of penalty.
- ii. In case the contractor could not complete the work due to circumstances beyond his control even then extension of the time limit may be granted without levy of penalty but in the both above case the engineer should give following certificate.

“Certified that railway has suffered no loss due to late completion of work and the conditions of para 445S are satisfied.”

In case there is dispute/disagreement or difference between railway and contractor

- i. All disputes and differences of any kind whatsoever arising out of or in connection with the contractor whether during the progress of the work or after their completion and whether before or after the determination of the contract, shall be referred by contractor to the railway and railway shall within a responsible time after their presentation, make and notify decision there on in writing. The decision, direction, classification, measurements, drawing and certificates with respect to any matter the decision of which is specially provided by the engineer on behalf of railway or matter which are referred to

hereinafter has excepted matters and shall be final and binding upon contractor and shall not set aside on account of any informality, omission, delay or error in proceeding in or about the same or any other ground or for any other reason and shall be without appeal.

- ii. In the event any dispute or difference between the parties as to the construction or operation of contract, or the respective right and liabilities of the parties on any matter in question, dispute or difference in any account to which the contractor may claim to be entitled to, or if railway fails to make decision within a reasonable time, the contractor after 90 days of presenting his final claim on disputed matters may demand in writing that dispute may be referred to arbitration giving details of claim.

In regard to appointment of arbitrator clause no. 64(3) of general condition of contract may be referred.

ARBITRATION

Arbitration may be termed as a device for settling up the differences of the two parties of a contracts agreement i.e. the administration and contractor through intervention by third person called arbitrator without the help of the court of law.

As per clause 63 of GCC all dispute in connection with contract shall be referred by the contractor to the railway administration in writing. The executive engineer is required to notify the decision of railway in the matter to the contractor within a reasonable time.

Clause 64 of GCC provide that in the event of any dispute, the contractor may demand for referring the matter arbitration after 90 days of the presenting his final claim on disputed matters to be refereed to arbitration.

There will be no objection to the work being continued during the arbitration and payment arranged in a normal course unless the arbitrator decides otherwise. In case where the claim in question is below Rs. 5lakh and if no complicated issue are involved the issue will be referred to as sole arbitrator nominated by GM.

Railways appoint one or more gazetted officer one rank above for arbitration and send it to contractor. The contractor can choose one officer for arbitration. When there will be two members in arbitration then one will have to be chairman.

Type of Dispute

Following types of disputes are possible in the contracts

- Claims for extra items of the work, quantum, rate of the payment, etc.
- Claims for the variation in the scheduled quantities.
- Delay in completion of the works.
- Compensation for prolonged duration of the works.
- Delay in payment of the bills.
- Delay in giving decisions on the matters referred.
- Disputes regarding non-scheduled items.
- Disputes regarding termination of the contract at contractor's risk and cost.
- Disputes regarding certain aspects of the measurements, specifications, drawings, defective workmanship, etc.
- Hire charges for the plant and machinery.
- Lacunae in contract conditions.
- Disputes regarding interpretation of any clause of contract.

INDEX

ACCIDENT AND DISASTER MANAGEMENT

S. No	Description	Page No	
		From	To
1	Rail Wheel Interaction	25	25
2	Permanent Way Parameters	26	33
3	Readings in Permanent Way	34	36
4	Rolling Stock Parameters and Readings	37	38
5	Accidents and features of Disaster management	39	45
6	Duties of Official Staff	46	58
7	Duties of on board railway staff after accident	59	59

RAIL WHEEL INTERACTION

Normally a vehicle follows the track geometry both in the vertical and lateral directions. Vertical guidance is obtained by the weight of the bogie of the vehicle (and the load inside the vehicle) transferred to the wheel through suspension. Lateral guidance is ensured by the wheel flange.

The design of a 4-wheeled railway vehicles consists of an under frame. The under frame has two sole bars and two head stocks. The wheel sets are housed inside four axle guards. Springs are provided between the under frame and wheel at the four axle guards. These are generally laminated springs.

In Bogie Vehicle, the vehicle body is placed on two bogie truck having a pair of sole bars and head stock and housing two wheels sets.

The under frame of a 4-wheeler and the bogie truck of an 8-wheeler can be compared to a table with four legs. A table will start rocking in one of its legs is short or is placed on uneven surface.

The wheels of a vehicle have similar tendency, but the suspension provided between the wheel and under frame helps the wheel to follow the unevenness of the rail table.

For instance, if the right leading wheel of a 4-wheeler or bogie truck negotiates a dip in the rail table, the wheel will follow the rail table since the spring placed above this wheel opens out, simultaneously with the diagonally opposite spring and keep the wheel in contact with rail table.

Let the track is newly laid to correct gauge, i.e. 1676 mm. Let a vehicle with a new wheel be placed on the track. The gauge for a new wheel is 1600 mm. The thickness of flange when measured at the root is approximately 34 mm. Adding the thickness of the two flanges, the flange to flange distance measured at root of flange will be $1600+68 = 1668$ mm. Thus, there is a clearance of 8 mm. When the gauge of the track reduced to -5mm, the clearance gets reduced to 3 mm and thus helps to improve riding comfort. Let us assume that one of the wheel flanges is reduced to 20 mm thickness. Then the slope of $\tan 2.5^\circ$ of the flange is also lost.

Therefore, the thickness of the flange at the root of flange will also be approximately 20 mm. Now, the distance between the root of flanges will be $1600+20+34$ mm = 1654 mm. Thus, the clearance between standard track gauge and the wheel flange becomes 22 mm. This will increase the lateral oscillation make the riding uncomfortable and unsafe.

PERMANENT WAY PARAMETERS

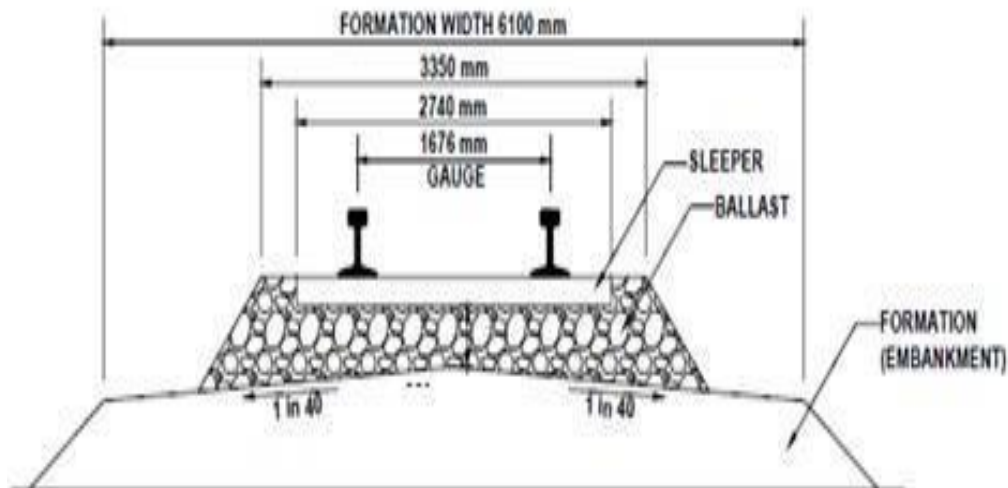
Introduction - TRACK

Track or Permanent Way is the Rail Road on Which Trains Run. It is basically consists of two parallel rails having a specified distance in between and fastened to sleepers, which are embedded in layer of Ballast. The Rail are jointed each other by fish plate and bolted and these are fastened to the sleepers by various fitting like keys and spikes etc. The sleepers are spaced at a specified distance and are held in position by getting embedded in ballast.

Each of the components of track has a basis function to perform. The Rail act as girder to transmit the wheel loads of train to sleepers. The sleepers hold the rail in proper position and provided a correct gauge with help of fittings and transfer the load to the ballast. The Ballast is placed on level ground known as formation. The Sleeper are embedded in ballast, which gives a level surface provides drainage and transfer the loads to a larger area of formation. The formation gives a level surface, where the ballast rest and takes the total load of the track and that of the trains moving on it.

Track Consists of:

1. Rail
2. Sleepers
3. Fitting and fastenings
4. Ballast
5. Formation



Cross Sectional view of Indian Railway track

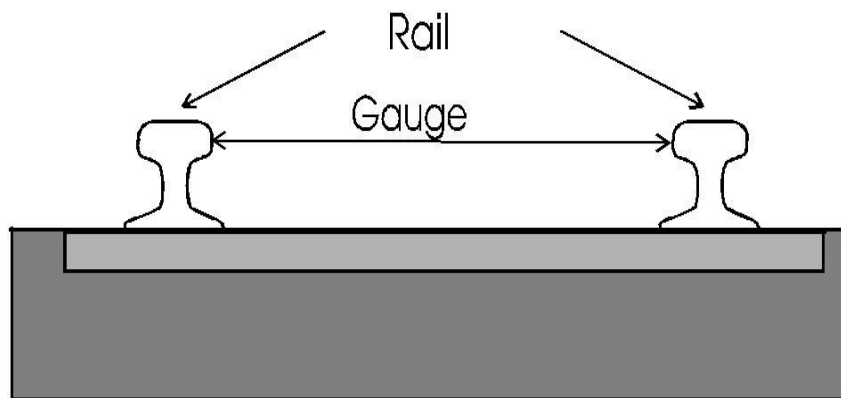
Requirement of Good Track

- The gauge should be correct and uniform
- The Rail should have perfect cross level. In curves, the outer rail should have proper super elevation to take into the centrifugal forces
- The track should be resilient and elastic in order to absorb shocks and vibration of running train
- The track should have good drainage so that the stability of the track is not Affected due to water logging

- The track should have good lateral strength so that it can be maintain its stability due to variations of temperature and other such factors
- There should be provision of easy replacement and renewal of various track components
- The track should have such structure that not only initial cost is low , but its maintenance cost is also minimum

Track Gauge

Gauge of track is normally defined as the minimum distance between rails forming track. It is measured at 13 mm below from the rail table with the help of P. Way Gauge called CGLI (Combined gauge cum leveling instruments).



Track Gauge Tolerances

- **On straight Track** 1676 ± 6 mm
- **On Curved Track**
 - When Curved radius more than 440 M 1676 mm tight 6 mm and Slack 15 mm
 - When the curved Radius less than 440 M 1676 mm tight 0 mm and Slack 20 mm

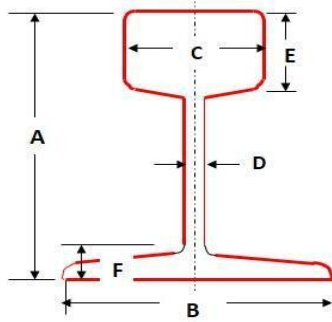
Rail

The rolled steel section (Steel girder) laid end to end on sleeper to forma track is called Rail

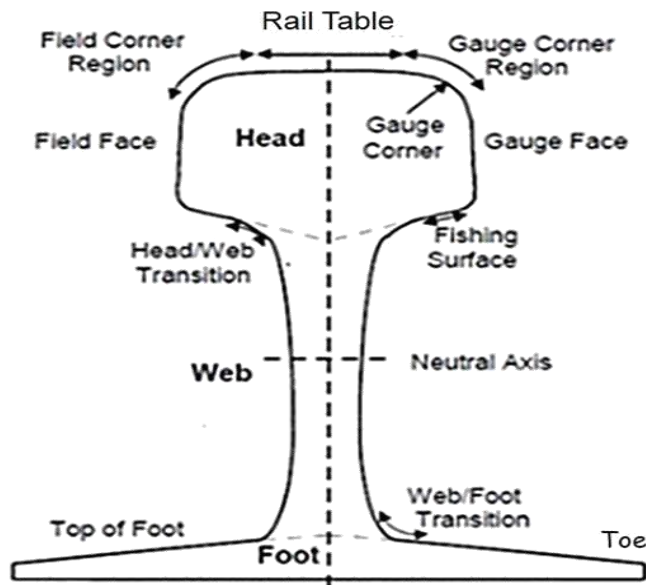
Rails Function

- The rails provide continuous and level surface for movement of trains
- The Rail provide a pathway which is smooth and has very less friction
- The Rail bear the stresses developed due to vertical loads transmission and due to braking force and thermal stresses
- The Rails transfer the Lad to the wider area of formation through sleepers and ballast

The Standard Rail Sections (BG) used in Indian Railways are 60 KG, 52 Kg and 90 R



Rail Section	Wt/M (in kg)	Area Of section mm ²	DIMENSIONS IN mm.					
			A	B	C	D	E	F
60 kgs	60.34	7686	172	150	74.3	16.5	51	31.5
52 kgs	51.89	6615	156	136	67	15.5	51	29
90 R	44.61	5895	142.9	136.5	66.7	13.9	43.7	20.6



RAIL NOMENCLATURE

SLEEPERS

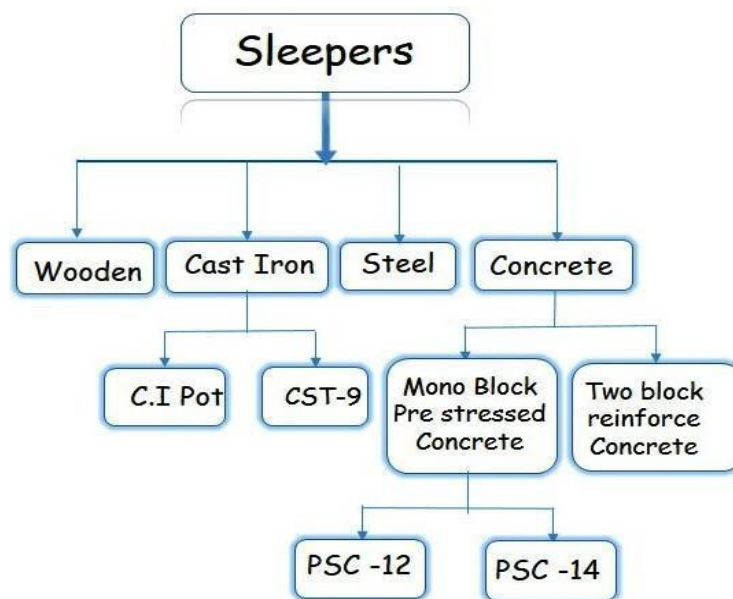
Sleeper is a load distributing component of track structure which is laid transversely to hold the rail.

FUNCTIONS

1. To transfer the load from rail to the wider area of ballast
2. To hold the rail to correct gauge and alignment
3. Other function of sleepers are :
 - a) To provide satisfactory rail seat
 - b) To Permit rail fastening being maintained in tight condition
 - c) To maintain inclination of rail
 - d) To provide adequate insulation between two rails in track circuited area
 - e) To provided lateral and longitudinal stability to Track

The sleeper is required to embedded into the ballast upto the top of sleepers so as to optimise the longitudinal and lateral resistance from sleeper ballast interface.

TYPES OF SLEEPERS



Presently Mono Block Pre stressed Concrete sleepers being utilized. There are two types of Mono Block Pre stressed Concrete

1. PSC -12
2. PSC -14

PSC -12 Sleepers is used with 52 Kgs Rails and PSC -14 sleepers is used with 60 Kgs Rails. The PSC -14 (60 Kg rail sleeper) can be utilized with 52 Kgs with different thickness of Liners.

SLEEPER DENSITY

The Sleeper density for all track renewal (Complete track renewal and trough sleeper's renewal), doubling gauge conversion, and new line constructions works shall be 1660 Nos /KMs

For LWR /CWR Even on Loop Lines or sidings minimum sleepers density shall be 1540 Nos /Kms In case of SWR Sleeper density is fixed as 1340 Nos /Kms

BALLAST

In the track geometry, ballast plays an important role. It absorbs noise, shocks, and vibrations and distributes the load transmitted by the wheels over the formation. The ballast provides a flexible base to the track and controls the lateral and longitudinal movement of track. It keeps the track in position and at required level. If sufficient quantity of ballast is not available, track may get distorted and or buckled. The recommended ballast size is 50 mm. The profiles and minimum depths should be as given in Para. 263 of IRPWM.

Types of Ballast

- a) **Cushion Ballast:** The depth of ballast below the bottom of sleeper, normally measured under the rail seat, is termed as cushion ballast.(Fig.)

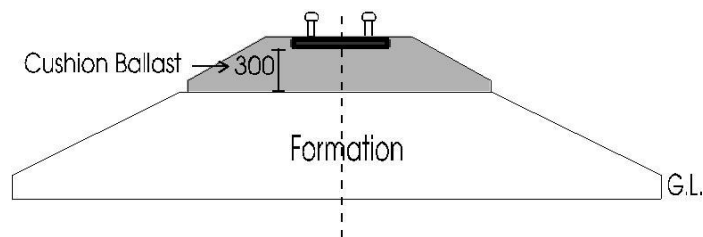
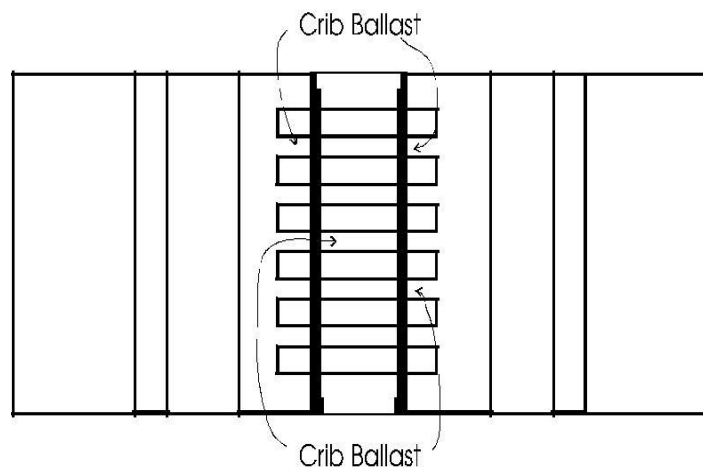
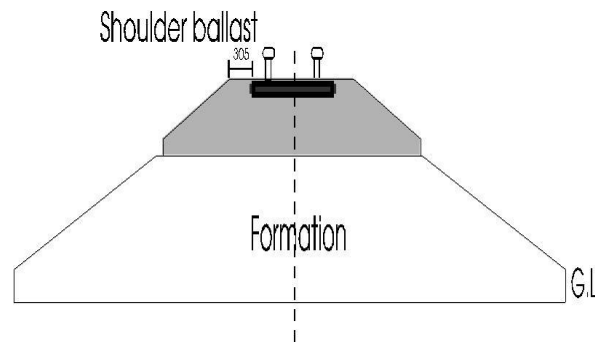


Fig.

- b) **Crib Ballast:** Ballast provided in between the sleepers is termed as crib ballast. (Fig.)



c) **Shoulder ballast:** Ballast provided beyond the sleeper edge is called shoulder ballast.



At deep screening and relaying spots, the top table or gauge face of the rail gets smeared by ballast. This enhances friction at the flange contact area and encourages mounting of wheel especially in case of empty stock. The running surface of rail should therefore be maintained clear of ballast particles.

Ballast Resistance

The ballast plays an important role in absorbing shocks. The factors affecting the ballast resistance are:

- Ballast material
- Size
- Shape of ballast particle
- Ballast profile
- State of consolidation
- Type of sleeper

FORMATION

The railway track is laid over a formation (having Inclination 1:40) prepared on soil (Fig. 4.1). The strength of formation depends upon the type of soil i.e. sandy, loam clay etc. and it serves the following purposes:

- Distributes the weight of train, track and ballast over a wide area of natural ground
- Facilitates good drainage.
- Provides a smooth and regular surface on which the ballast and track can be laid
- The formation is affected by following factors:
 - Sudden subsidence of embankment
 - Base failure
 - Ballast puncturing due to heavy rains, Muddiness etc.

The inadequate care taken in maintaining the formation may cause derailments as failure of formation results in disturbance of track geometry. The steps to be taken for avoiding derailments on account of formation failure include measures to prevent sinking of track during diversions and use of new formations especially during rains.

The geometry of track should be maintained as per laid down standards for passage of traffic at stipulated speeds. Where abnormal behavior of formation or supports is expected, the track geometry and packing/supports must be checked regularly or as often as warranted.

CREEP

Creep is defined as longitudinal movement of rail with respect to sleepers. The rails have a tendency to move gradually in the direction of traffic.

Causes of Creep

- Rails not properly secured to sleepers
- Less Ballast resulting in inadequate ballast resistance to the movement of sleepers
- Improper expansion Gaps
- Badly maintained rail joints
- Rail seat wear in metal sleeper track
- Rail too light for the traffic carried by them
- Skidding and Slipping of Wheels
- Sharp gradient and sharp curves
- Other miscellaneous cause of improper maintenance of track such as lack of drainage, loose packing uneven spacing of sleepers

Effect of Creep

- Sleepers get out of square affecting gauge and dittoing alignment
- Rail Joint get opened out resulting bolts holes getting elongated and premature fracture of fish plate and bolts
- The joint gets continuously jammed
- The suspended joints start becoming supported joint and rail ends get battered
- Buckling takes place in extreme cases of creeps

BUCKLING

Buckling of track occurs when high compressive forces are created in the rails associated with inadequacy of lateral resistance in the track at the place.

SUPER ELEVATION OR CANT (Ca)

Super elevation or cant is the difference in height between the outer and inner rail on a curve. It is provided by gradually lifting the outer rail above the level of the inner rail. The inner rail is taken as the reference rail and is normally maintained at its original level.

The main functions of the super elevation are

- To ensure a better distribution of load on both rails.
- To reduce the wear and tear of the rail and rolling stock.
- To neutralize the effect of lateral forces.
- To provide comfort to passengers.

CANT DEFICIENCY (Cd): Cant deficiency occurs when a train travels around a curve higher than the equilibrium speed. It is the difference between the theoretical cant required for such high speeds and the actual cant provided.

CANT EXCESS (Ce): Cant excess occurs when a train travels on a curve at a speed lower than the equilibrium speed. It is the difference between the actual cant provided and theoretical cant required for such a low speed.

EQUILIBRIUM SPEED

When the speed of a vehicle negotiating a curved track is such that the resultant force of the weight of the vehicle and of radial acceleration is perpendicular to the plane of the rails, the vehicle is not subjected to any unbalanced radial acceleration and is said to be in equilibrium. This particular speed is called the equilibrium speed. The equilibrium speed as such is the speed at which the effect of the centrifugal force is completely balanced by the cant provided.

EFFECT OF LESS SUPER ELEVATION

Due to less super elevation, there is possibility of outer rail getting worn out as it will bear more strain due to tendency of wheel more away from the centre of the curve under the influence of centrifugal forces.

EFFECT OF MORE SUPER ELEVATION

- Inner rail will have to bear maximum strain and there is every possibility of this rail giving.
- Due to excessive super elevation, there is every possibility of slow moving goods trains getting derailed.

READINGS IN PERMANENT WAY

Derailment on straight Track and curved track

Causes of derailment can be broadly divided in two groups.

1. Distortion of track parameters.
2. Failure of track components.

Track parameters.

- (a) Gauge
- (b) Cross Level (called Super Elevation on curve)
- (c) Twist
- (d) Alignment (Versine on curve)

Gauge

On straight track	- 6 mm to + 6 mm.
On Curve with radius more than 440 m.	- 6 mm. to + 15 mm.
On Curve with radius less than 440 m.	- Up to + 20mm.

Gauge should be uniform as a good practice. Slack gauge beyond above limit causes angularity, while tight gauge causes thrust to the fittings and ultimately results track distortion.

Cross Level

In respect to a reference rail, variation in level of other rail is called cross level. The resultant effect of cross-level is twist. On straight track it is called cross-level and on curved track it is called superelevation.

Super elevation: Super elevation is also known as Cant.

Maximum super elevation which can be provided are as under.

- B.G. High speed route (A, B& C): 165 mm
- B.G. Other route (D&E) : 140mm

Cant deficiency

- B.G. 75mm (100mm on high speed route)

Cant excess

- B.G. 75mm

Twist: Algebraic difference of cross-level per metre length of track is called Twist. Service tolerance for Twist for B.G is 2.78 mm. per metre for 'D' class route

Versine: On straight track it is known as alignment whereas on curved track it is known as versine.

Alignment on Straight Track: On straight track tolerances limit for alignment is 5mm measured on 7.2 metre chord

DERAILMENT ON POINTS & CROSSING (TURNOUTS)

Track parameters to be inspected at the turn out.

Gauge	+ 6mm. preferred at the toe of switch.
Switch Opening	95 mm. to 115 mm.
Clearance of check rail and at the nose of crossing	Max. 48 mm. Min. 44 mm.
wear at the crossing nose	Max. 10 mm.
Switch wear	Max to a length of 200 mm

Derailment on points & crossing (turnouts)

Followings are the causes of derailment on points & crossings.

- Improper setting of points causing gap.
- Failure of interlocking arrangements.
- Lifting of toe of switch.
- Sharp flange splitting through the point or mounting the same.
- False flange may force open the switch in trailing direction which would cause derailment, when a movement in the opposite direction takes place immediately.
- Bursting of point.
- Tight gauge at the nose of crossing due to burring of crossing nose or wing rail.
- Slack clearance at the check rail and nose of crossing.
- Badly maintained turn in curve.

Failure of track components

- (I) **Rail failure:** Incidences of frequent rail/weld failure due to rail defect like. Hogging, Battering, scabbing, wheel burns, Corrosion (Vertical wear, lateral wear) beyond limit. Loss of section and expected Service of rails. Detail in transparency.
- (II) **Fish plate failure:-**This defect develops in a badly maintained joint and excess gap at joints
- (III) **In effective and deficient fittings:-** Due to such fittings vertical lateral and longitudinal stability of track is badly affected.
- (IV) **High percentage of unserviceable sleepers:-** Due to high percentage of unserviceable sleepers it becomes difficult to retain packing, hold Gauge& Alignment ultimately track geometry is disturbed. Percentage of unserviceable sleeper should not be more than 25%.
- (V) **Un-serviceable joints sleepers or two consecutive sleeper un-serviceable:-** In such condition gauge holding become poor at these location joints are the weakest link of the track. If joint sleepers etc. are un-serviceable maintenance of joints are disturbed causing low, hogged, and battered joints and spread of gauge etc.

- (VI) **In adequate ballast:-** Main functions of the ballast are as under
- (a) To give lateral stability (which arrest alignment defects buckling)
 - (b) To give longitudinal resistances (which arrest creep)
 - (c) To provide cushion (to give resiliency)
 - (d) To facilitate drainage.
 - (e) To transfer load from sleeper to formation.
- (VII) **Formation failure:-** Bearing capacity of certain (such as black cotton soil) is reduced in rainy season. Formation failure can happen due to heavy breach subsidence's scour slip and sinkage.
- (VIII) **Improper Formation width and slop:-** If formation is not of proper width it cannot retain shoulder ballast and ultimately lateral stability of track is reduced which may cause misalignment and buckling in worst case. Due to improper slop of bank drainage is affected.
- (IX) **Buckling of track: -** Buckling of track is a serious incidence there are various defects which contribute buckling.

ROLLING STOCK PARAMETERS AND READINGS

The rolling stock involved in accident must be inspected in the presence of nominated team of supervisors and results should be recorded in the prescribed formats.

The main items of inspection are as under:

WHEEL GAUGE

Wheel gauge is the distance between inside faces of the flange on the right and left side wheels of an axle. There should be no variation in the values of wheel gauge measured at four point 90 degrees apart on a wheel set. However the actual value of the wheel gauge can vary as per given below.

	Standard	Maximum	Minimum
BG	1600 mm	1602 mm	1599 mm

If the wheel gauge is more than permissible limit, there exists a possibility of a relatively newer wheel hitting the nose of crossing. This happens because the wheel gauge is one of the parameters affecting the clearance at check rail opposite the nose of crossing.

If the wheel gauge is less than minimum value, there is a possibility of wheel hitting at the back of a tongue rail while passing through the switch and thus damaging the tongue rail.

WHEEL DEFECTS

The following aspects should be checked on the suspected wheels:

- a. Condemning limit
- b. Flat places on tyre/skidding
- c. Flanges - Sharp / Deep/thin
- d. Radius too small at the root of the flanges
- e. Gauge Slack/ tight
- f. Cracks

The above mentioned defects can be detected with the help of **Tyre defect gauge** and **Wheel gauge** meant for this purpose.

Thin Flange

When the flange thickness reduces to less than 16 mm for B.G., the flange is called a thin flange. It should be measured at the distance of 13mm below the flange tip. A thin flange increases lateral play between the wheel set and track and increases:

Sharp Flange

This occurs when the flange wears in such a way that radius at the tip of the flange becomes less than 5 mm. The flange forms a fine sharp edge. Due to this, the wheel set can take two roads at slightly gaping point or wheel may ride over the chipped tongue rail.

Less Radius at Root

When radius at the root of the flange becomes less than 13 mm, it is called worn out flange. A worn out flange increases the value of frictional forces

Deep Flange

When the depth of flange, measured from the flange top to a point on the wheel tread (63.5 mm away from the back of B.G. wheel), becomes greater than 35 mm, it is called a deep flange (35-28.5=6.5 mm). Under this condition, the wheel flange would tend to ride on the fish plate and check-block and may damage the track components.

Hollow Tyre

When the projection of outer edge of the wheel tread below the hollow of the tyre exceeds 5 mm, the outer edge of the wheel forms a false flange and the worn tread is called hollow tyre.

The hollow tyre has the danger of developing a false flange. The wear on tyres has the effect of increasing the conicity of the wheel tyre. This reduces the critical speed of the rolling stock beyond which excessive hunting and oscillations take place and the chances of derailment.

Flat Places on Tyre

The maximum permissible value of flatness on a B.G. wheel tyres is as under

- Goods Stock IRS - 60 mm
- Coaching Stock - 50 mm

Buffing gear

Buffer projection limits from head stock

Max. 635 mm Min 584 mm

Buffer Height variation between adjacent Coaches Should not be more than 75 mm.

ACCIDENT AND DISASTER

ACCIDENTS

Accident is an occurrence in the course of working of railway which does or may affect the safety of the railway, its engine, rolling stock, permanent way and works, fixed installations, passengers or servant or which affect the safety of others or which does or may cause delay to train or loss to the railway.

For statistical purposes accidents have been classified in categories from “A” to “R” excluding “I” and “O”.

CLASSIFICATION OF ACCIDENTS

Accidents are classified under following heads

- Train Accidents
- Yards Accidents
- Indicative Accidents
- Equipment Failures
- Unusual Incidents

Train Accidents: The Train Accidents is an Accident that involves the trains. The Train accidents are further divided as:

- Consequential Train Accidents
- Other Train Accidents

Consequential Train Accidents includes train accidents having serious repercussion in terms the loss of human life, human injury, and loss to Railway Property or interruption to Railway traffic.

Other Train Accidents all other Accidents which are not covered under the definition of consequential Train Accidents are to be treated as other train Accidents.

Yards Accidents all Accidents that take place in a yard and do not involve a train are termed as Yard Accidents

Indicative Accidents: In real terms they not Accidents but are serious potential hazards and include all cases of train passing signal at danger, Averted collision, breach of block rules.

Equipment Failure: These include all failures of Railway Equipment that is failure of Locomotives, Rolling Stock, P way, OHE, S & T equipment.

Unusual Incidents: These includes cases related to law and order but not resulting in Train Accidents and other incidents under classification and N, Q and R

Detailed Classification of Accidents

S.No	Class	Types of Accidents
1	A	Collision
2	B	Fire in Train
3	C	Accidents at Level Crossing
4	D	Derailment
5	E	Other Train Accidents
6	F	Averted Collision
7	G	Breach of Block Rules
8	H	Train Passing Signal at Danger
9	J	Failure of Engine and Rolling Stock
10	K	Failure of Permanent Way
11	L	Failure of Electric Equipment
12	M	Failure of S & T Equipment
13	N	Train Wrecking
14	P	Causalities
15	Q	Other Incidents
16	R	Miscellaneous

Threshold Value: For the Purpose of Accidents Threshold Value is the minimum Value beyond which the Accidents will be treated as having serous repercussion on the basis of loss to Railway Property or interruption to communication, it shall constitute two portions

- A. Threshold value of Railway Property: Loss which is fixed at One Lac Rupee.
- B. Threshold value of interruption to communication either partial or total where duration of interruption is equal to or more than Numbers of hours specified as under

Interruption	BG- A , B , C , DSpl (in Hours)	BG - D - E Spl (In Hours)	BG - E (in Hours)
Total	3	4	6
Or	Or	Or	Or
Total + Partial	6	8	12

Duration of Interruption is defined as duration from the time of Accidents till starting of first train on line clear from the adjacent station for movement over the affected Line in that section

RELIEF TRAIN ARRANGEMENTS

Sounding of Accident Alarm Signals/Hooters/Sirens: The Accident Alarm Sirens/Hooters must be sounded immediately when ARME/ART is ordered. Following codes are prescribed for sounding the accident alarm/ Sirens/Hooters:

Sr. No.	CODE	CIRCUMSTANCES
1.	Two long blasts each of 45 sec Duration with 5 sec break in between.	Accidents in loco sheds/ traffic yards at Home station requiring only ART.
2.	Three long blasts each of 45 sec Duration with 5 sec break in between.	Accidents outside the home station Requiring only ART.
3.	Four long blasts each of 45 sec Duration with 5 sec break in between.	Accidents requiring both ARME and ART.
4.	One long blasts of 90 sec duration.	Cancellation of ARME/ART.

Note:

1. The alarm hooters requiring ARME/ART shall be sounded as prescribed above and shall be repeated once more after interval of five minutes.
2. The SSE (Loco), SSE(C&W) and all other supervisory staff concerned must ensure that the relief train gangs break down gangs and other staff who is required to go to the accident site in the ARME or ART, thoroughly understand alarm hooter and that their names and addresses are displayed at conspicuous places.
In case of medical staff required to attend the accidents, a phone message is also to be sent to the ADMO/AMO concerned.

On listening to these hooters, the SSE (Loco), the ADMO/AMO will immediately report himself to ASM on duty with his staff, ready to proceed to the site of accident with the relief medical van. The target time for reporting to the ASM after hearing the hooter is 15 min. during the day and 25 min. during the night.

Accident relief medical equipment and auxiliary van

The accident relief medical equipment (ARME SCALE-1) and auxiliary van are stabled in station yard. The function of ARME SCALE-1 is to carry medical equipment and personnel to the site, for prompt medical relief. The auxiliary van has provision of emergency tools for removing the injured persons from the debris etc. In case of accident involving or likely to involve injuries or deaths, these shall be rushed to the site immediately.

A. Target time for turning out of medical relief van from the siding and their dispatch from the stations:

In case of double exit siding:

Time for turning out	= 15''
Time for Dispatch	= 5''
Time from ordering dispatch	= 20''

In case of single exit siding:

Time for turning out	= 25''
Time for dispatch	= 5''
Time from ordering to dispatch	= 30''

Note: the above target time for turning out is reckoned from the time of ordering to the time they are taken out from the siding and kept ready for dispatch on a suitable running line plus 5 min. for dispatch.

B. Target time for turning out of accident relief train:

The target time for turning out of accident relief train (ART) with complete equipment and staff from the loco shed (or the place where it is stabled) and dispatch from the station, are under as:

During day:

Time for turning out	= 30''
Time for dispatch	= 15''
Target time from ordering to dispatch	= 45''

During night:

Time for turning out	= 45''
Time for dispatch	= 15''
Target time from ordering to dispatch	= 60''

Note:

1. Both the target times 30'' and 45'' for turning out accident relief train are to be reckoned from the time the accident relief train is ordered to the time the train reaches the loco shed exit point. 15'' time is the time permitted for departure from the station. Any delay in ordering or departure of medical van/ART must be immediately examined and viewed seriously.
2. At stations where the layout of the loco and traffic yard are such as to permit a reduction in the time limits stipulated above, the divisional railway manager should lay down shorter time limits.
3. Accident relief train (ART) or break down train is equipped to deal with relief, rescue and restoration measures.

Promptness in movement of ARME and ART

1. If an engine is not readily available, the nearest engine of any train including mail/express trains should be released and utilized for expeditious dispatch of these.

2. ARME and ART must be given precedence over all other trains while proceeding to the site of accident.
3. ARME/ART should not be detained for want of guard but may leave in the charge of any responsible loco/traffic official. A guard may be sent by the quickest possible means later on.
4. ARME/ART or any special relief train, carrying injured persons for removal to hospitals, must also be given top most priority.
5. The accident relief trains after completing relief operations must be worked back to their base stations without any delay and must be given precedence over all goods trains.

DISASTER

Disaster is an accident or an incident that would result in huge loss of human lives, animals and property e.g earth quake, floods, cyclone, drought and epidemic diseases etc . As far as Railway Concerned , major accident involving passenger train resulting in loss of human lives or grievous injury and affecting /dislocating the train services and causing damage to the goods , rolling stock and interruption to through traffic if lasting more than 24 Hours .

Disasters on Railways may be due to railway accidents or due to natural causes such as earth quake, cyclone and flood and some manmade causes such as fires, industrial accidents, bomb explosion etc. Disaster have the potential to cause extensive damage to life and property and adversely impact society at large.

Strengths of the Railways to handle a Disaster

In handling disasters, Indian Railways is in a unique position as it has a number of strengths not available with many other departments of Government of India. These include:

- Railways' own Communication Network.
- Operating Control on each Division linked with each Station.
- Territorial Army Units.
- Uniformed force of RPF/RPSF
- Railways' own Medical Infrastructure
- Civil Defence Organization
- An army of Gang men spread out all over the Indian Railways.
- Scouts and Guides (they can at best provide background support).
- Dedicated Rescue/Restoration and Medical Equipment on Rails.

Each of the above can be made use of to handle adversities depending upon requirement to handle the disaster.

Railway's shortcomings to handle Disaster:

There are, however, a few inadequacies in the Railways own resources which are very essential for handling a specific type of Disaster as under:

- Absence of Tunnel rescue equipment – in case of collapse of or mishap in a rail Tunnel, expertise and related equipment on this aspect is lacking.
- Non-availability of trained divers for extrication of passengers and/or casualties (dead

bodies and drowning/drowned passengers) from rolling stock fallen down in sea / river /lake etc. Limited help of sport persons (swimmers) can be taken for this , the time of their mobilization is a factor to be kept in view

- Non-availability of cranes operated from a ship/barge for lifting of the coaches/bogies from a water body.
- Ability to handle a CBRN Disaster and major fire.
- Limited resources to handle a terrorist attack on a train and/or a station, **other Railway Premises etc.**

Disaster on Railways Context:

The concept of a Disaster was, till the year 2005, not adequately and comprehensively defined on Indian Railways. It was accepted that a Disaster situation implies, on the railways, to cover only cases of serious rail/train accidents. It was, perhaps, due to this anomaly as late as the year 2008 DM on Indian Railways has broadly adopted this fact in the concept of disaster and has gone to examine the relief/rescue/mitigation and preparedness of Indian Railways based on the earlier concepts and has reviewed the facilities for handling disasters available with the Railways only on the report/recommendations of the HLC on DM of Mr. S. Dhasarathy.

Based on the definition of the Disaster Management Act 2005, Ministry of Railways has adopted the following definition of Railway Disaster:

“Railway Disaster is a serious train accident or an untoward event of grave nature, either on railway premises or arising out of railway activity, due to natural or man-made causes, that may lead to loss of many lives and/or grievous injuries to a large number of people, and/or severe disruption of traffic etc, necessitating large scale help from other Government/Non-government

TYPES OF DISASTER

Disaster in the Railway Context was traditionally a serious train accident, caused by human /equipment failure, which may affect normal movement of train services with loss of human life or property or both. This is now extended to include natural and other man-made Disasters. Different types of Disasters are describing along with a few example below.

(a) Natural Disaster

Earthquakes, Floods, Cyclone, and Land slide, Snow avalanches, Tsunami etc.

(b) Train Accident related Disaster

Collision (with a huge no of casualties) Train Marooned (Flash floods) , derailments on a bridge over a river and coaches falling down , train washed away in cyclone , derailments of a train carrying explosive or highly inflammable material , tunnel collapse on a train , fire or explosion in trains , and other misc. cases etc .

(C) Manmade Disaster:

Acts of terrorism and sabotage i.e causing deliberate loss of life and / or damage to property, which includes; - Setting a train in fire, Railway installations etc,. Bomb blast at Railway station / Train, chemical (Terrorism) disaster, biological , radiological and nuclear Disaster

Golden Hours

The first responsibility in case of accidents is to keep the loss of life to minimum .The response team must be reach and extricate accident victims as early as possible and organize effective trauma care. The basic Principle of trauma management is speed and expediency. Thus the first hour after the accident is termed as “The Golden Hours”

Who should responds in golden Hours

- Public
- Social Workers
- Non-Government Organization (NGOs)
- Fire Fighting Units
- Local Police and army Units
- Govt. and Private Hospitals
- Railway Rescue teams

DUTIES OF OFFICIAL AT ACCIDENT SITE

ACTIONS TO BE TAKEN DURING SERIOUS ACCIDENTS

DRM will inform civil authorities & Police Department of concerned district to rush to help. He will ask for the medical team also from state Govt. DRM will demand for NDRF battalion through HQ and Rly. Board, if required for relief & Rescue operation as they are Medical First Responder (NFR)

ACTIONS AT THE SITE

Golden Hour

If a critical trauma patient is not given definite medical care within one hour from the time of accident, chances of his ultimate recovery reduces drastically, even with the best of Medical attention thereafter. This one hour period is generally known as The Golden Hour.

During this Golden Hour period every effort should be made to:

- Render definite medical care to the extent possible preferably by qualified medical practitioners.
- Stop bleeding and restore Blood Pressure.
- Persons under shock should be relieved of shock immediately.
- Transport casualties to the nearest hospital so as to reach within this Golden Hour period.
- For being effective, any Disaster Management system should aim at recovering as many critical patients as possible and rushing them to hospital within this period.

Disaster Syndrome:

A victim's initial response following a Disaster is in three stages, viz. Shock stage, Suggestible stage and Recovery stage. These initial responses are called Disaster Syndrome.

- Shock stage: In which victims are stunned, dazed and apathetic.
- Suggestible stage: In which victims tend to be passive but open to suggestions and willing to take directions from rescue workers and others.
- Recovery stage: In which individuals may be tense and apprehensive and may show generalized anxiety.

Different phases of Disaster Response

Disaster Response in case of a railway accident constitutes of 3 phases. These 3 phases are determined both by the time factor, as also by the extent of specialized assistance available. Firstly, it begins with the spontaneous reaction of men available on the train at the time of the accident. Thereafter the second phase continues with contributions made in rescue and relief work by men and material available locally in nearby areas of the accident site. The third and longest phase consists of meticulously planned action by trained DM teams who arrive at the accident site to carry out rescue and relief operations.

The first phase which is of shortest duration last for about half an hour. It is an amateurish, poorly equipped effort; but is nevertheless the most important phase. In most cases, this is the only help available for a major part of the 'Golden Hour'.

The second phase which is of 2-3 hrs. duration is comparatively less amateurish and much better equipped. Their contribution is vital since the 'Golden Hour' period comes to an end during the working of this group. How many critically injured passengers can finally be saved depends solely on the efficiency of this group.

The last and final phase of Disaster Response by railway's DM team continues for a few days. It comes to an end not only with the restoration of traffic but with the departure of most relatives and next of kin from the accident site and disposal of all bodies. Few of the grievously injured who continue to be hospitalized for comparatively longer spells are then the sole responsibility of railway's medical department.

With the above scenario in mind, it is necessary to take firm and quick decisions to save lives and property. To achieve these objectives Railways have a well-defined action plan that is successfully executed by the coordinated efforts of different disciplines, all of whom function as a team. The three groups which are active during the above mentioned 3 phases of Disaster Response may be classified as follows:

- Instant Action Team (IAT)
- First Responders (FR)
- Disaster Management Team (DMT)

INSTANT ACTION TEAM (IAT): Instant Action Team comprises of:

- The Guard, Crew, TS, TTEs, AC coach attendant, Asstt. Guard, RPF and other railway staff on duty on the accident involved train.
- GRP staff traveling on the train on duty.
- Railway staff traveling by the accident involved train either on duty or on leave as passengers.
- Doctors traveling by the train.
- Passengers traveling on the train who volunteer for rescue and relief work.
- Railway staff working at site or available nears the site of the accident.
- Non- Railway personnel available at or near the accident site.

Pre- accident check list of preparation for Members of Instant Action Team.

- Generally, about 15" time elapses before information regarding occurrence of an accident reaches the Divisional control Office. In case information can be conveyed immediately this time can be saved. . This 15" time is of vital importance since it constitutes 25% of the 'Golden Hour'.
- In case they have a Mobile, ensure that telephone numbers of all relevant officials such as those of divisional control offices etc. have been permanently fed into the Mobile for immediate use in an emergency.
- These important telephone numbers should cover all those sections where they are required to work their train either within their own division or even those of adjoining divisions.
- Divisions will get printed and circulate a DM Telephone Directory containing all such telephone numbers that are likely to be required in an emergency.
- Whenever they are traveling at night they should keep a torch handy and secure it by some means. The torch will be of no use in an emergency if it cannot be taken out from inside the suitcase at that point of time; or if the torch cannot be located since it has fallen off due to severe jerk.

Duties of the Guard of the affected Train

- Note the exact time of the accident and kilometer.
 - Protect the adjacent line(s) and the train as per GR. and SRs thereto;
 - Secure the vehicles as per rules.
 - Ascertain if adjacent line (s) is/ are fouled.
- Make a quick survey, for an immediate action, of the casualties, injuries and assistance required;
- Relay the information giving details of the accident and assistance required to the control by the most expeditious means.
- Render first aid to the injured person(s) taking assistance of all available Railway Staff, Doctors and volunteers on train or near the site of accident;
- Illuminate the affected area as much as possible with EL Box fittings (if accident occurred as night time).
- Get the particulars of damage to the rolling stock, permanent way etc.
- Arrange to shift the injured persons to the nearest hospital with the help of all available staff and other volunteers, also keep their particulars;
- See that water, tea etc, are supplied to the affected passengers as far as practicable;
- Arrange protection of Railway and public property with the help of available police and Railway staff.
- Preserve all clues relating to the possible cause of accident;
- Post an available Railway employee on the field telephone to ensure regular- flow of information;
- Check the unaffected portion of the train and arrange to clear the same safely to the adjacent station(s) as per rules and in consultation with the control/station Master(s) concerned;
- Remain in overall charge till replaced by a senior Railway official and permitted by the Competent Authority;

Notes: In the event of any disability of the Loco pilot the duties devolving on the Loco pilot, for protection of the line/ line(s) shall devolve on the Guard or on a Railway servant deputed by him.

Duties of Loco Pilot of the affected train

- Note the time of the accident, and kilometre;
- Protect the adjacent line (s) at the front end of the train as per GR 6.03; 9.10 and SRs thereto, as the case may be ;

Note: In the event of any disability of the Guard, it will be the responsibility of the Loco Pilot to ensure protection of obstructed adjacent line(s) and the train in the rear as per GR 6.03 and SRs thereto and to give quick information to the Control/ Station Master;

- Take such precautions as may be necessary or as prescribed by special instructions to render his locomotive safe,
- Render all possible assistance to the Guard in rescue and relief measures.

Duties of Assistant Loco Pilot of the affected train.

- Assist the Guard/ Loco Pilot in conveying accident messages to all concerned.
- Help the Loco Pilot in protection of the site of accident.
- Render all possible assistance to the Guard in rescue and relief measures.
- Carry out any other job assigned relating to accident by the Loco Pilot of the train.
- Man the engine in absence of the Loco Pilot.

Duties of the Train conductor/ Train superintendent.

- Assist the Guard in rendering first aid to the injured persons(s) and shifting them to the Hospital.
- Look after the comfort of the passengers, injured and un-injured alike.
- Assist the passengers for protection of their luggage.
- Make out a list of injured/ dead passengers.
- Preserve reservation charts to know the particulars of injured/ dead passengers.
- Organize to transship/ transfer passengers and their luggage to the passenger special.
- Assist for arranging snacks, tea, coffee & drinking water to the injured and other passengers detained at the site of accident.
- Collect the addresses of the relatives of the injured/dead passengers to send information regarding accident.
- Look for the assistance of any Doctor or para Medical staff (Railway. Non – Railway) traveling in the train.

Duties of Coach Attendant

The coach attendant shall work under the guidance of Train conductor/ Train Superintendent.

Duties of Travelling Ticked Examiner (TTE)

- The TTE should work under the guidance of the train Conductor/ Train Superintendent.
- Similar actions as mentioned in (4) above should be initiated by the TTE for his nominated coach.

Duties of A.C. Mechanic

- He should immediately “Switch Off” the current where necessary to avoid short circuiting.
- He should also assist Commercial staff i.e. Train conductor/ Train Superintendent/ TTEs in their duties at the accident site.
- See that the emergency lights inside the Coaches are in working order.

The Senior most RPF Officer available

- Segregate the area of incidence by establishing temporary barriers by use of nylon ropes (if available) or any other make shift device available at the site to protect the area against the entry of spectators into the affected place.
- Luggage of passengers should be isolated and protected and consigned goods are taken care off till they are handed over to claimants or taken over by the Railway.
- He should respond to any call for assistance to rescue victims and transport them to nearest Hospital.
- He shall maintain close liaison with the Officers of various departments of the Railways, GRP, Local Police and Officers of Civil Administration.

Railway Staff travelling on the accident affected train:

- Whenever a train is involved in a serious accident with casualties/injuries to passengers, all railway staff travelling on the train either on duty or on leave are deemed to be on duty with immediate effect.
- Under no circumstance should any of them leave the accident site unless and until divisional officers arrive, take over charge of rescue and relief operations, and permit them to leave.
- Railway staff on train/at site shall volunteer themselves to render assistance and report to TS/TTE/Guard of the Train.
- The senior most officers travelling on the train will assume charge as Officer-in-Charge Site
- Normally the senior most officers will be travelling in either the 1AC or in 2AC coach and most probably in the HOR quota section of the coach. The HOR section of 2AC is invariably in the center of the coach (berth nos. 19 – 22). In any case the TS/TTE would know who the railway officers are travelling in 1AC or 2AC.
- Similarly, other railway staff will be travelling in 3AC coach; and most probably in the HOR quota section of the coach.
- Similarly, some Group ‘D’ railway staff may be travelling in Sleeper coach; and probably in the HOR quota section of the coach.
- In the absence of any officer, the TS or senior most TTE/Guard will discharge duties listed out for OC Site.

Duties of OC Site – Immediately after the accident:

- Note down the time of accident.
- Ensure protection of traffic by Guard and Driver.
- Ensure reporting of accident to nearest Station/Control.
- Roughly assess the extent of damage and likely number of casualties.
- Collect railway staff and volunteers from amongst the passengers and form different groups. Each of these groups should be assigned work as detailed at item 6 below.
- Maintain a log of events.
- Till Divisional Officers arrive and take over charge of the situation, continue to discharge duties of OC Site.
- After Divisional Officers arrive, fully brief the DRM hand over charge to him.
- The on-board OC Site should ensure issue of a detailed message with following information before leaving the site of the accident.
- Time/Date of accident.
- Location Km./between stations.
- Train number and description.
- Nature of accident.
- Approximate number of killed/injured.
- Extent of damage.
- Assistance required.

- Condition of the adjacent line, if any.
- Whether OHE is involved.
- From here onwards, the DRM of the accident involved division takes over charge as OC Site.

Formation of Groups comprising members of Instant Action Team:

- OC Site shall immediately collect all Railway staff on train/at site and form separate groups.
- Passengers travelling by the same train who volunteer for rescue and relief work should also be drafted into these groups.
- Passengers from accident involved coaches should be directed towards their own coach.
- Passengers from coaches which are not affected can be distributed amongst other accident involved coaches.
- In the absence of OC site, TS/TTE shall take steps to form such groups.
- In the absence of TS/TTE the Guard/Assistant Guard shall take steps to form such groups.
- 5 or 6 groups should be formed depending on number of coaches involved.
- Ideally, one group should be formed for handling each coach.
- In case sufficient numbers of officers are present, then one officer should be made in-charge of each group.
- Otherwise, Sr. Supervisors travelling by the accident involved train should be nominated as in-charge of each group to co-ordinate its working.
- In case sufficient numbers of Sr. Supervisors are also not present, one TTE should be nominated as in-charge of each group to co-ordinate its working.
- Each group should rescue injured, entrapped passengers.

Duties of members of Instant Action Team – Till arrival of Divisional Officers

- If a person is bleeding and loosing blood, or if he is unconscious, then in that case you have to act quickly. ‘Golden Hour’ should be kept in mind. You may have at the most only one hour’s time on hand.
- In such cases, immediately administer First Aid to the injured passenger and try and stop further loss of blood.
- Persons trained in first aid may do ‘Cardio Pulmonary Resuscitation’. This may save several lives.
- If the door is open and is accessible, then uninjured passengers should be helped to come out from the door.
- In AC coaches the windows panes should be broken open in order to let in fresh air for the occupants, and thereafter to evacuate them.
- Non – AC coaches have one emergency exit window on each side. The position of this emergency window is 5th from the left when facing the line of windows from inside the coach. They are opposite berth nos. 23 and 57. In case the door is locked and jammed, try and open these windows so that some of the uninjured passengers can come out through the emergency exit.

- Special care should be taken while evacuating the old, infirm and children in order to ensure that they are not separated from their family members.
- Extrication of critically injured should be done under medical supervision as far as possible.
- In case medical supervision is not available, then critically injured passengers should be made to lie down on a bed sheet and thereafter taken out by 4 persons holding the four corners. This will ensure that no further damage takes place. (Bed sheets will be available in AC coaches).
- Passengers who are bleeding from open cuts should be tied up with strips of cloth so as to reduce if not stop the bleeding altogether.
- It is better not to take out the luggage from inside the coaches at the first instance, for two reasons. Firstly, passengers both injured and uninjured should get preference in this evacuation process. Secondly, it may be safer for the luggage to be left inside where there are less chances of their being stolen or pilfered.
- After passengers have been evacuated from your coach, cross check with the reservation chart and against the name of each passenger note down as to whether he/she is injured or not.
- After all passengers have been evacuated; water and eatables can be taken out gradually.
- Building up confidence of injured passengers by suitable advice is of great importance.
- After helping evacuate all passengers from your coach go over to the unreserved coaches and provide similar help to those passengers also.
- Railway officials from divisional HQ generally arrive at the site of the accident within 2 to 3 hours, depending on the distance of the accident site from the divisional HQ qrts. Wait for them to come and make further arrangements.
- Grievously injured passengers who are bleeding or those who are unconscious require immediate hospitalization. In case some local people have arrived by that time, their help should be taken in shifting the grievously injured to the nearest hospital.
- In case your train has been involved in an accident but neither has your coach derailed nor are any passengers of your coach injured, then you should go to the unreserved coaches and carry out the duties as listed above.

Duties of OC Site - till arrival of divisional officers

Having formed different groups consisting of available railway staff on the train and volunteers from amongst passengers, the rescue and relief work should be got started in right earnest. This entire exercise would take about 30" time. Once the rescue and relief work by the **Instant Action Team** has got underway, the OC site should then devote his attention to contacting **First Responders**.

- Locating nearby villages:
- Locating the nearest manned level crossing gate :
- Organizing assistance from local people available in nearby villages

Relief & Rescue Operation

Duties of Official- in charge at the site

The senior most official present at the site of the accident shall be in overall charge of the relief operation till he is relieved by another official deputed by the Administration to take over the charge. However, the senior most official of the Mechanical Department shall be in charge of the relief train. The senior most official present at the site of a serious accident, shall-

- Take general charge of the situation and take action to provide all possible assistance;
- Depute Officers/ senior subordinates and all other staff on specific duties in-
 - Assisting the rescue operation, if any;
 - Assisting the preservation of clues;
 - Assisting the transshipment work, if any;
 - Taking action to remove the obstruction as soon as possible;
 - Ensuring the protection of adjacent line (s) and the affected train as per rules.
- See that the portable telephone is installed and manned constantly by a responsible staff, and ensure adequate lighting of the accident area at night;
- See that the injured persons if any are rendered first aid and shifted promptly for medical aid;
- Ensure to get clearance from Police authorities in case of suspected sabotage;
- Make an immediate assessment of the following, with the help of the available doctors and / or others;
 - The number of persons killed, and of those sustaining grievous, simple and trivial injury;
 - extent of damage;
 - The expected period of suspension of traffic.
 - Assistance required;
 - Prima facie cause of accident;
- See that dealing centre is opened at the site of accident and manned-
 - To keep the details of persons killed, injured , and action taken in each case;
 - To relay the above information in details to the Divisional Headquarters'
 - To attend to public enquiries and
 - To relay the progress of relief work;
- Ensure recording of all information at the dealing centre concerning the accident and the relief operations in the form of an Accident Log Book;
- See that immediate action is taken to protect and safeguard property;
- See that proper assistance is given to the injured, ladies children and the aged;
- Arrange for transporting the stranded passengers preferably to stations where drinking water, catering arrangements etc. are available, unless they can be sent to their destinations;
- See that the arrangement is made for preservation and proper care of dead bodies, if any, till further disposal'

- See that obstruction is cleared in the minimum possible time, and every action taken for this purpose;
- Arrange. For speedy ex- gratia payment as per extant rules.

Duties of Railway Medical Officer

The nearest Railway Medical Officer, on receipt of the report of a serious accident with injury to person. Shall-

- Reach the site of accident with the Medical Relief Train or by the quickest available means, with all men and material commensurate with the serious of the accident;
- Render medical aid to the injured at site;
- Make timely and adequate arrangements for shifting the injured persons to suitable hospitals as considered necessary for further treatment;
- Keep detailed particulars of the dead and injured e.g. their name, address etc. as far as available.
- Deal with the dead and injured as per extant rules and instructions.

Duties of Medical Superintendent/ Divisional Medical Officer

- Ensure the availability of prompt and adequate medical facilities;
- Co- ordinate with Civil/ Military/ State/ Private medical authorities for the purpose;
- In case of an accident to a passenger carrying train, reportedly attended with casualties and / or grievous injuries, unless otherwise advised by the Divisional Railway Manager, proceed to the site of the accident by the first available means.

Duties of Commercial officer at site

The Sr. Divisional Commercial Manager or in his absence the Divisional/ Assistant Commercial Manager, on receipt of information of a serious accident, shall:

- Reach the site of accident by the quickest available means;
- See that immediate arrangements are made to protect the area and safeguard the property;
- Look after the comfort of the passengers, injured and un- injured alike;
- Ensure prompt supply of refreshments, free of charge, to the injured persons and also make adequate arrangement for refreshment and drinking water for the passengers detained at the site of accident for any reason;
- Ensure, in co- ordination with Medical officer (s) at site, preparation of a complete list of injured and dead persons;
- Arrange for adequate number of porters for carrying luggage and parcels in case of transshipment etc.
- See that the doctors are assisted by porters and other staff in attending to the injured and for shifting them to the hospital;
- Ensure the making over to the dead bodies to the Police for disposal;

- Arrange preparation of a complete list of damaged consignments;
- See that the proper arrangements are made for the transshipment of passengers and their luggage at the site of accident if required, as also for transshipment/ unloading of parcels/ affected wagons, if required;
- Ensure preservation of documents of damaged parcels, Mails and Goods etc.
- Senior most railway officer at the site of the accident shall be the designated Site Manager.
- Management of rescue operations- Primarily Mechanical and Medical departments. Assistance to be provided by all railway men (irrespective of their department) as needed.

Preservation of clues

- Officer or senior subordinate of any department who may happen to be present at the time of an accident took place or who first arrives at the scene of an accident shall, irrespective of whether he is on or off duty, record the statements of the staff concerned and take whatever steps maybe necessary to record or preserve evidence which subsequently might not be available. All clues shall be preserved with a view to enabling reconstruction of the scene at a later date. This is essential even though the civil and police officials may have inspected the scene of the accident and photographs may have been taken. For this purpose, the concerned official shall specially take steps to note the condition and exact position of (i) Vehicles, (ii) Track, (iii) Points, (iv) Signals, (v) levers operating the points and signals,(vi) Breakage of axle, spring , locking bolt and cotter etc, (vii) Any obstruction, (viii) Any tampering , (ix) Engine and its speed recorder, etc. This should be done before commencement of actual restoration operation.
- A complete and accurate dimensioned sketch of the accident showing the position of vehicles and their condition, permanent way including any detached damaged components, should be made out by the Engineering official and signed by made out by the Senior Engineering and Operating official of the Railway as also by the Senior Police official present. In the case of any signal or level crossing at the site of the accident, a detail position of the same should be indicated in the sketch.
- In case of sabotage and suspected sabotage, every possible action shall be taken to ensure that any finger prints or foot prints observed at the site of accident are not obliterated.
- Statements of responsible passengers or eye –witness with their names and addresses who may have witnessed the accident should be recorded. These statements should be signed jointly by the passenger /eye-witness, Railway Official and Civil or Police authority.
- The Railway Official /Inspectors /Supervisors who may happen to be present at site at the time of accident or who arrives first at the site of accident ,shall also scrutinize ,the train register /Logbook , Station Diary ,Line Clear Message book ,Private number book ,Caution Order, Line admission book , etc. and initial them with date and time indicating the irregularities noticed. In the cases where these records are connected

with the cause of the accident, immediate action must be taken to seize the relevant records and seal. In cases where defects of any instrument or /and interlocking gear may have caused or contributed to an accident ,the instrument of /and the interlocking gear concerned shall be sealed and not be opened /used except on the authority of the Divisional Railway Manager or his duly authorized representative .

- In cases of serious accidents with loss of human life or grievous hurt, the restoration work should normally be limited to the removal of dead bodies and injured persons from the debris, if any, and wherever by laying a diversion, if it is expected that the Commissioner of Railway Safety may have the benefit of personal examination of the site of accident undisturbed.
- Wherever possible, photographs of the wreckage shall be taken, which may afford the clue to the cause of the accident .For this purpose, the procedure laid down in para 7.05 of the accident Manual should be followed.
- In all case of derailments, the marks on the wheels of engine and /or vehicles and marks on the permanent way (rail, sleepers, fishplates etc.) in respect of the wheels mounting on and dropping from the rails, the wheels riding on the ballast etc. shall be specially looked for and recorded. The position of rails, sleepers, fish bolts turnouts etc which bear marks as a results of the accident, especially between the points of mount and drop shall be marked and numbered serially with chalk or paint and carefully preserved .A defects and damages to rolling stock shall be examined in details and recorded immediately after the accident as also the details of the loads i.e. weight, contents, evenly or unevenly loaded etc.
- Any, engine, vehicle or other material involved in an accident which is likely to be required for exhibition before any higher official or enquiry committee must be set apart and must not on no account be utilized for the purpose of the working of the Railway, till it is examined by the said official
- Speed recorded in the locomotive should be examined including its chart. The same may be seized with the signature of the Loco Pilot
- In case of serious fire accident in train, after the fire is put out, the affected coaches/wagons or the portion of the Railway property which caught fire should be preserved carefully for inspection by Forensic Scientist.
- Railway Officials/Inspectors/Supervisors who may happen to be present at the time of accident or who arrive first at the site of accident shall see that the fire is completely put out and nothing which can lead evidence for the cause of fire including affected Coaches/Wagons is disturbed. However, the Coaches/Wagons may be drawn out from the site cautiously, in order to clear obstructed section and be kept on the siding nearest tothe accident spot with the permission of competent authority.
- One photographer with camera and necessary equipment should form integral part of the group of staff who accompany the ARME and ART.

The Accident Relief Medical Van must be dispatched to the site of accident within 15 minutes from the base station after sounding of the hooter.

Supply of Refreshments, foods and beverages to the passengers and staff at the site of accident

- (a) Refreshment, food and beverages may be supplied free of charges to all the affected passengers, injured or uninjured, stranded at the site or at the station where they are shifted for further action..
- (b) **The senior most officer at the site shall have the powers to**
 - Arrange conveyance for the affected passengers free of charge.
 - Incur expenditure, if necessary, for supplying free food to the affected passengers.
 - The Sr. DCM or in his absence DCM/ACM shall be responsible to take necessary action in this regard.

Dispatch of free messages/ sue of dot telephones/ mobile phones free of cost

- (a) Messages to the close relatives conveying the news of safety of those traveling by the train involved in a serious accident should be dispatched free of cost.
- (b) The passengers of the affected train, may be provided to use mobile phones/ Dot phones, where ever feasible, free of cost. Station Master/ Railway officers at the site of accident may hire cell phones for this purpose.

Accommodation of the relatives of the deceased.

As an additional relief measures; the relatives, of the deceased/ grievously injured passengers may be allowed to use the waiting rooms and retiring rooms free of charge if considered necessary, without detriment to the convenience of other passengers.

Issue of Complementary passes.

Complementary passes may be issued to the victims who are discharged from the hospitals and their close relatives, to return to their destinations.

Safe Custody and appropriate disposal of the luggage.

RPF and Commercial staff at the site of accident should co- ordinate their activities regarding safe custody and appropriate disposal of the luggage of the dead and injured passengers. These luggage should be guarded by the RPF personnel and thereafter can be handed over to the rightful claimants.

Care for the trapped/ injured

- (a) Officers and staff of all departments, at the site of accident shall keep close co-ordinating with one another for taking all necessary actions to extricate injured passengers from the debris.
- (b) On arrival at the site of accident, the Railway medical officials shall offer medical aid as best as possible & shall arrange for the transport of the seriously injured persons to the nearest available hospital promptly.
- (c) A Railway medical officer must as far as possible accompany the injured to the hospital and see that they are properly accommodated for further treatment.
- (d) Each of the seriously injured persons must be given a ticket, showing his name, address, name & address of nearest relative, the time and place of accident probable

diagnosis and treatment given. This ticket may be placed round the neck of the person for the guidance of the hospital.

- (e) Officer of all departments shall render all possible assistance to the medical officer in his effort to reach the site of the accident with his medical team and to give treatment to the injured.
- (f) Train carrying injured persons from the site of the accident shall be given priority over all other trains. The controller and Deputy Chief Controller of the concerned division shall be responsible for this.
- (g) In the event of injured persons being treated at non-railway hospitals, the senior most medical officer of the division will maintain close liason with the hospital authority, in order to keep information's of latest developments.

Video Coverage at Accident site.

Prior to undertaking restoration measures at an accident sites, suitable video film overage should be arranged where ever feasible. Outside trade may be hired for the purpose. DRMs shall take suitable actions accordingly.

Commercial, Safety, Medical and Mechanical officers are authorized to withdraw money from the station earnings in these cases.

DUTIES OF ON BOARD RAILWAY STAFF AFTER ACCIDENT

- Don't panic. Once the accident has already occurred and the train has come to a standstill nothing worse can happen.
- In case you have a Mobile and it is working, inform the divisional control office immediately about the accident.
- Observe the position in which your coach has stopped; whether it is standing upright or turned upside down or lying on its side.
- Try and see whether your coach has stopped on a bridge or whether there is level ground on both sides.
- In case the coach is on a bridge or very high embankment or in case it is raining heavily, then it is better to wait for some time and not be in a hurry to leave the coach. You may be jumping from the frying pan into the fire.
- Search your coach with your torch and try to determine the general position.
- See that passengers don't panic either. Passengers sometimes make things worse for themselves by panicking at this critical moment. Try to calm them and build up their confidence.
- Ascertain whether passengers are injured or not; and whether any of them are trapped or pinned down inside the debris.
- Call out aloud and find out whether there are any doctors present.
- Doctors who are travelling in the coach should be asked to announce their presence so that they can attend to and help injured passengers.
- Call out aloud and find out whether there are any railway staff present.
- Railway staff who are travelling in the coach should be asked to announce their presence so that they can attend to and help other passengers.
- For each coach, form a core team comprising of railway staff available, doctors and 3 or 4 uninjured passengers from the same coach. This core team should take the lead in helping remaining passengers both injured and uninjured.

INDEX
SUPERVISORS SKILL

S. No	Description	Page No	
		From	To
1	Leadership and Leadership Style	61	63
2	Motivation	64	66
3	Communication	67	69
4	Time Management	70	71
5	Stress Management	72	74
6	Inter Personnel Skill	75	77
7	Energy Conservation	78	79
8	Role of Vigilance	80	81

LEADERSHIP AND LEADERSHIP STYLE

Leadership Definition:

Leadership is a quality of leading a group of people or an organization or ability to do this.

Leadership involves:

- Establishing a clear vision
- Sharing that vision with others so that they will follow willingly
- Providing the knowledge, information and methods to realize that vision
- Coordinating and balancing the conflicts of all members

Difference between Leader and Manager:

- Manager have employees but leaders win followers
- Manager react to change but leaders create change
- Manager have good ideas but leaders implement them
- Manager communicate but leaders persuade
- Manager direct groups whereas leaders create teams
- Manager tries to be hero but leader make heroes of everyone around them
- Manager take credit but leaders take responsibilities
- Manager are focused but leader create shared focus
- Manager exercise power over people but leader develop power with people

Qualities of Good Leaders:

A successful leader should have following qualities in his behavior:

(i) Sense of objective/mission

A good leader should have knowledge of objectives of organizations, rules and regulations of organization etc. he should be committed towards the job, workers and fulfilling the objectives of organization.

(ii) Educational competency

A leader or supervisor should have complete knowledge of the job done under his supervision. Also he should be a technically competent person.

(iii) Exemplary character

It is of utmost importance that a leader is trustworthy to lead others. True authority is born from respect for the good character and trustworthiness of the person who leads.

(iv) Maturity

Good leaders are tolerant of ambiguity and remain calm, composed and steadfast to the main purpose. Storms, emotions and crisis come and go and good leader take these as a part of the journey and keeps a cool head.

(v) Administration

A good leader as well as keeping the main goal in focus is able to think analytically not only does a good leader view a situation as a whole but is able to break it down into subparts for closer inspection. Also a good leader can break it down into manageable steps and makes progress towards it.

(vi) Attitude and confidence

A good leader is confident, enthusiastic, energetic and healthy. He should always keep a positive attitude and try to motivate his gang.

(vii) Knowledge of industrial psychology & human relation

A good leader will be enthusiastic about their worker. People will respond more openly to a person of passion and dedication. Leader should understand the workers problem and should know how to deal with it.

(viii) Team player and socialize

A leader should be a good team player and also he should be socially in touch with his team members.

(ix) Communication

Being able to clearly and successfully describe what you want done is extremely important. If a supervisor can't relate his vision with his team member, they won't all be working for same goal. Communication skills of a leader should be perfect.

(x) Vision

A good leader should have the ability to anticipate the situation or problems that may arise in future and also he should work accordingly.

(xi) Open mindness & flexibility

A good leader will not be affected by the negative conditions arise while work. Also he will neglect small mistakes done by his team members.

(xii) Cheerfulness

A good leader should always be cheerful. A cheerful and open minded person can motivate workers easily.

TYPES OF LEADERSHIP

Following are the types of leadership

(i) Authoritative or autocratic leadership

An autocratic leader assumes all the responsibility for decision making for initiating action and for directing, motivating and controlling his subordinates.

Autocratic leader thinks he is the only competent and capable person to make decisions. The autocratic accomplish his duties through fear of penalties.

Advantages:

- Fast decisions
- Can control those people who are not willing to work in normal way.

Disadvantages:

- No workmen participation in decision making process
- Too strict control on workers
- Workers feels insecurity

(ii) Democratic leadership

A democratic leader practices leadership by consultation. Even though workers participate in decision making process. The final decision is taken by the leader only. The leader becomes more supportive in his contact with workers.

Advantages

- Least no. of disputes
- Workers will be encouraged
- Workers get motivated
- Increase team spirit

Disadvantages

- This type of leadership is only possible when the workers are not biased

(iii) Free Rein Leadership

In this type of leadership, leader depends completely on his subordinates to establish their own goals and to make their own decisions. This leader assumes the role of just another member or the group.

Supervision/Managerial Functions:

Works are of two types as follows

- Job centered supervision
- Employee centered supervision

Advantages of good leadership:

- Increases workers motivation to do work
- Increases workmen's confidence
- Workers involvement to fulfill objectives of organizations
- Increases productivity
- Increases production
- Increase in profit
- Better working atmosphere
- Increases bonus to workers
- Improvement in workers living condition/lifestyle
- Improvement in quality of work
- Reduce/stop spend thrift

MOTIVATION

Main objective of motivation is to produce an effect of self-involvement of workers in work and to attain the aim of organization.

It is important to motivate workers. If a supervisor wishes to ensure good quality of job and better productivity from his gang or team he has to encourage or motivate his workers.

Types of Motivation

(i) Positive Motivation

Following points are involved in positive motivation

- Appreciation of workers
- Provision of increments
- Provision of Promotion
- Provision of Incentives
- Provision of Bonus schemes
- Provision of job security to workers
- Various amenities/privileges
- Improvising methods of work
- Providing privileges to workmen's family
- Workers involvement in decision taking

(ii) Negative Motivation

Following points are involved in negative motivation

- Punishes the workers
- Disciplinary action on worker
- Withholding of increment
- Withholding of promotion
- Reduce incentives
- Reduce bonus
- Reduce privileges or amenities
- Make workers feared about removal from job
- Reduce privileges to workers family
- Transfer
- Fine on workers

Techniques of Motivation

- (i) The carrot and stick method
- (ii) Motivation through good leadership principles
- (iii) Mosh laws theory
- (iv) Herzberg's two factor theory
- (v) X & Y theory

(i) Carrot and Stick method

This is an oldest method. In this system workers are motivated by giving awards (carrot) and also if not fulfilled the workers get punished (stick). Even though the method is older, is still in use.

(ii) Motivation through good leadership principles

A good leader should be role model to his workers. He should be committed towards work and also possess good behavior, confidence and technical as well as practical knowledge. An energetic & cheerful leader motivates his subordinates to do work.

(iii) Mosh law's theory

Mosh law put forward a theory on human needs in 1934 which categorized human need in 5 levels. Lowest level is basic needs & highest level is need of self-actualization. According to Mosh law, as soon as the workers attain one level, he will try to attain the next level & it will continue up to the fifth level.

These five levels are:

(a) Physiological need:

It includes basic needs of a human i.e. food, accommodation, clothing etc. everyone try to attain these basic needs.

(b) Security & safety needs:

Once a worker attains basic needs, tries to be safe & secure

- His job
- Working safety
- Security of salary, food, clothes etc.



Human Needs as per Mosh Law

(c) Social needs:

When all the above said needs of an employee get fulfilled, the need of social status arises. Human is a social being & they wish to get a better position in the society.

(d) Esteem need:

This need is related to self-respect, confidence, experience, power & control which is essential to motivate an employee. This also satisfies the ego of worker.

(e) Needs of self-actualization:

Here the worker is allowed to work as he desired in his desired post/position. And this is the last level in Maslow's theory.

(iv) Herzberg's two factor theory of motivation

Difference between Maslow's theory and Herzberg's theory is the difference in number of levels i.e. in Maslow's theory there are 5 levels whereas in Herzberg's theory levels are 2.

Maintenance Factor	A	Salary
	B	Job Security
	C	Working Conditions
	D	Company Policy & Administration
	E	Quality of Supervision
	F	Interpersonal Relations
	G	Status
Motivators	A	Recognition
	B	Advancement
	C	Responsibility
	D	Growth in the job
	E	Achievement
	F	Challenging Work

(v) X & Y Theory

X in this theory means that the worker who is not willing to work is to be assigned to such a work which he desired not to do. Y denotes the assignment of a good worker to a good & desired job by him.

COMMUNICATION

Communication is the activities of conveying information through the exchange of thoughts, messages or information as by speech, visuals, signals, writing or behavior. Communication plays a vital role in an organization.

Communication gap is a serious problem in organizations and even in families. Never stop communicating with your enemy too, because doing so will stop the chance of compromise. Communication requires –

- A sender
- A message
- A recipient

MEDIUM FOR COMMUNICATION:

Following are the most common medium of communication

- Communication through letters.
- Through emails.
- Through telephonic conversation.
- Face to face or group communication.
- Notice board.
- Organization's journals and magazines.
- Through surveys.
- Through complaint register.
- Organization's performance review.
- Through unions.
- Through organization's own communication system.

Medium for communication is chooses according to below said factors:

- a) Price/ cost
- b) Confidentiality of communication
- c) Necessity of feedback
- d) Trustworthiness of medium
- e) Clarity of medium
- f) Necessity of record keeping of communication

TYPE OF COMMUNICATION

(i) Formal communication

(ii) Informal communication

Formal Communication

This type of communication is a major factor involved in an organization. Formal communication is written, oral or graphic communication which follows the lines of authority and accountability. Formal communication has three channels-

- a) Upward Communication (vertical):** Upward communication flows from lower levels to the higher levels of the organization. E.g.:- A SSE communicating to Dy. CME.
- b) Downward Communication:** It involves flow of communication from higher level to lower level. E.g.:- Dy. CME is communicating to a SSE.

- c) **Horizontal Communication:** It is information exchange between departments as means of coordinating their activities. It occurs across same levels. E.g.:- A SSE to another SSE.

Informal Communication

The communication arising out of all those channels of communication that fall outside the formal channel is known as Informal Communication. It takes place due to the individual needs of the members of the organization. It may be upward, downward or horizontal.

Barriers to Successful Communication

The below mentioned barriers obstructs the communication, due to which information interchange is interrupted.

- a) In every organization there will be certain levels through which information is to be passed. Example JE ->SSE->AWM->WM->DEPUTY CME->CWM.
- b) In equal distribution of work i.e. difference in amount of work to be done by individual workers.
- c) Attitude: some people do not listen to others and thus only listen or pay attention to such things which they like to hear.
- d) Prestige and superiority complex: due to superiority complex and proud, some people do not pay attention to others and do not like to communicate with others and they think that no need to consider suggestions of worker lower to them.
- e) Prejudiced: for people always keep a prejudicing mentality .they consider others suggestions to be wrong even though that may be right.
- f) Biased nature: any officer /supervisor /worker should be impartial. Partiality causes communication gap.
- g) Emotionally upset receiver
- h) Receiver interprets his own meaning.
- i) Ignorance of points /disputed points.
- j) Not to communicate at proper time.
- k) Mobile phone
- l) Disturbances and noises.

Techniques to Improve Communication

- Use simple language and words or indecent.
- Do not use improper language or slangs.
- Use face to face communication.
- Use least number of mediums.
- Try to get feedback from receiver.
- Think before communicating.
- Maintain friendly and calm atmosphere in organization.
- Always try to stress on the important points.
- Emotional and mental condition of receiver should be considered while communicating.

- Use actions with words where it is necessary.
- Worker should be well instructed at the time of job distribution.
- Get feedback from workers in several intervals while doing a job.
- Discuss with the workers about the work soon after lunch interval.
- Instruct workers in groups also.
- Try to communicate with all workers at least once a day.
- Keep a record of communication where ever is necessary.
- Make notes of telephonic communications when necessary.
- Use minimum number of sentences and clear words while writing letter.
- Only talk when needed and do not talk in vane & do not deviate from topic.
- Be a good listener and do not interrupt others while talking.
- Do not involve in personal talk & do not hesitate to communicate.
- Do not get involved in meaningless talks.
- Be focused while attending a meeting.
- Switch off your mobile phone while attending meeting.
- Do not communicate in between noise and disturbance.
- Be impartial and behave impartially.
- Do not undergo influences & do not become prejudice.

TIME MANAGEMENT

Time management is the act or process of planning and exercising conscious control over the amount of time spent on specific activities specially increases effectiveness, efficiency or productivity.

In every project time management is an important factor which decides the total duration of the project. Below mentioned are the factors involved in the time management.

Factors involved in the time management

(i) **Creating an effective environment**

Keep things in neat and orderly at home and workplace so that effective utilization of time can be done. In order to make this possible better housekeeping technique to be brought into use.

(ii) **Setting priorities and goals**

Keep an aim for each project and try to attain that aim. Note down the aims and divide it into small fragments and plan accordingly. Set the priority while planning and fix a dead line for each action.

Analysis used in Time Management

(i) **ABC ANALYSIS:** This is used in business world.

A-Urgent works and works of importance

B- Important work but not urgent.

C- Neither important nor urgent.

(ii) **PARETO ANALYSIS:** In this method the total work is divided according to time taken.

80% of time to do 20% of work and

20% of time to do 80% of work.

Work is classified or divided into two groups and accordingly decide in which group the work falls in. this method increases productivity.

(iii) **Implementing Goals:** In this, a task list is made. Task list can help to memorize the important works. This is a type of self-management. The time required for each job is specified in the task list and is followed.

Simple Techniques of Time Management

(i) **Daily Planning:** A detailed plan of works to be done each day is to be made. This will make life orderly and help in self-control.

(ii) **Prioritize your Task:** Set priority for each and every task & set according to priority of job.

(iii) **Say “NO” to Nonessential Jobs:** Learnto say no those work which are not related to us. This will enable us to find enough time to do essential jobs.

(iv) **Delegate:** before doing any job, review it and understand the job and decide whether the job can be distributed to someone else or not.

(v) **Take time to do quality jobs:** take enough time to do quality works. These works consume more time. After getting experience this time can be reduced.

- (vi) **Break time consuming large jobs into small tasks:** Break large work into small task and plan the job accordingly. This will help in easy completion of big and complicated tasks.
- (vii) **Practice 10 minutes rule:** Allocate 10 minutes for dreaded works. This will reduced the effort to be put to complete these tasks.
- (viii) **Evaluate how you are spending time:** Make a diary and evaluate utilization of time for a period of three days. This will help us to understand which all activities are necessary and which are unnecessary. Also this will enable us to decide priority of job.
- (ix) **Limit distractions:** While doing works which need higher degree of concentration, try to avoid distractions by keeping the doors and windows shut, mobile phone switched off.
- (x) **Get plenty of sleep, eat a healthy diet and exercise regularly:** in order to maintain equilibrium in life it is necessary to get enough sleep. A healthy body bears a healthy mind. Regular exercise and healthy diet make a healthy body and mind.
- (xi) **Take a time management course:** It will help us to maintain time keeping in our life.
- (xii) **Take a break when needed:** Too much stress will cause mentally unfit for doing jobs. So it is better to take break whenever you feel frustrated or in stress.
- (xiii) **Ask for professional Help:** Even after applying all the above said methods, you cannot manage time properly. It is better to take help of a professional who is well experienced in time management.

Advantages of Time Management

- a) Better utilization of time
- b) Saves money.
- c) Stops spend thrift.
- d) Increases profit.
- e) Increases production.
- f) Increases productivity.
- g) Increase quality of product.
- h) Improves relation between worker and management.
- i) Better working conditions.
- j) Increases salaries of workers
- k) Increase bonus.
- l) Helps in nation's development.
- m) Lesser stress level.
- n) Stops unnecessary works.
- o) Improves personal and family life of worker.

STRESS MANAGEMENT

In this era, everyone is busy. All are busy with family, society or work. All these may induce stress. If this stress not manages properly, it may cause the worker not able to perform his daily duties effectively.

Definition

It is a technique which will help to reduce or control stress levels induced in a person from his daily activities.

- 1. Source of Stress in Your Life:** This is the first step in stress management. Review the habits or behavior of self, which causes stress. Identify what causes you more stress and how you manage it and what is its effect on your health.
- 2. Look at How You Currently Cope the Stress:** After knowing the source of stress, analyze how you are dealing with it and the way you are dealing with it in healthy or unhealthy manner. Below mentioned are some of the unhealthy ways of stress relieving:
 - a) Smoking
 - b) Drinking Liquor
 - c) Overeating
 - d) Less eating
 - e) TV or computer addiction
 - f) Avoid friends and family
 - g) Taking drugs
 - h) Sleeping for long durations
 - i) Being angry unnecessary''
- 3. Dealing with stressful situations:** Lot of people take help of four a technique to get a relief from stress.

Change situation

- 1A. Avoid stressor
- 2A. Alter the stressor

Change your reaction

- 3A. Adopt to stressor
- 4A. Accept the stressor

- 4 Stress management strategy:** Below mentioned 6 strategies are involved in this-
 - a) Avoid unnecessary stress.
 - b) Alter the situation.
 - c) Adopt to the stressor.
 - d) Accept the things that you cannot change.
 - e) Make time for fun and relaxation.
 - f) Adopt a healthy life style.

Avoid Unnecessary Stress: It is not possible to avoid all kinds of stress. Still some of these stresses can be avoided as mentioned below-

- i. Learn to say "NO":** Do not accept jobs which do not come under your responsibilities.
- ii.** Avoid people who induce stress in you.

- iii. **Control situation/atmosphere around you:** If TV news/ radio news makes you stresses, try to avoid them. If traffic makes you stressed, travel when there is less traffic.
- iv. Avoid disputed subjects in talk.
- v. Make a list of works according to priority.

Alter the Situation: If you can't work in a stressful situation, try to change it and think how you can change it so that it will not produce stress again.

- i. Do not suppress your feelings.
- ii. Be ready for compromise.
- iii. Face the situations.

Adopt to the Stressor: If you can't alter the situation or stressor, try to adopt the stressor and change self.

- i. Learn the problem: Understand the problem and seriousness of problem.
- ii. Positive attitude or be optimistic: instead of being pessimistic, thinking of failure of past, try to be optimistic by recalling the success of part and increase your confidence.

Accept the thing that you cannot change.

Find time for rest and entertainment: it is necessary to take rest and entertainment, in order to keep our self-energetic. Below mentioned activities are:

- | | | | |
|---|--------------------------|----|---------------------------|
| 1 | Jogging | 9 | Exercising |
| 2 | Going to garden | 10 | Yoga and aerobics |
| 3 | Keeping pet | 11 | Wear good clothes |
| 4 | Reading | 12 | Pray to the god |
| 5 | Listening music | 13 | Meet friends and family |
| 6 | Watching good movies | 14 | Sense of humor |
| 7 | Agarbattis or fragrances | 15 | Do not be jealous |
| 8 | Playing sports and games | 16 | Go for picnic with family |

Adopt a healthy life style: Resistance to stress can be increased by adopting a healthy life style.

- i. Exercise: Exercise for 30 minutes for 3 days in a week.
- ii. Balanced Diet: Have a balanced diet. Over eating and less eating are symptoms of stress. Sleep a while after lunch, walk a mile after dinner.
- iii. Avoid taking drink and smoking.
- iv. Have enough sleep.

Advantages of Stress Management

- a) Workers improve interest in job.
- b) Happy workers.
- c) Less spend thrift.
- d) Increased production.
- e) Increased productivity.
- f) Increased profit.
- g) Improved life style of worker.
- h) Good worker-management relation.

What is Stress

It is natural reaction of thinking.

Symptoms of Stress

- i. Repeating the same thing again and again.
- ii. Muttering
- iii. Being depressed
- iv. Fainting
- v. Acidity
- vi. Head ache
- vii. Painful muscle
- viii. Shivering
- ix. Diarrhea
- x. Sleeplessness
- xi. Being over exhausted
- xii. Impotency

Causes of Stress

- i. Death of spouse
- ii. Divorce
- iii. Death of family member
- iv. Sickness/ accident of self or family member.
- v. Bachelorship
- vi. Unemployment/ removed from job
- vii. Retirement
- viii. Sexual problem
- ix. Change in diet

Life is Experiences

- i. Past is Experience
- i. Present is Experience
- ii. Future Experience

Use your experience in your experiment to achieve your expectation.

INTERPERSONAL SKILL

DEFINITION

Interpersonal skills are the skills which we used in our daily life when we interact with others and society. People with interpersonal skills are more successful in life than others.

Types of interpersonal skills

(a) **Listening skills:** this is the art of listening and understanding any message conveyed by speaker because of listening skills any company can keep their customer happy and satisfied. This increases productivity, sales and reduce errors.

10 principles of listening are:

- Stop talking
- Prepare yourself to listen
- Allow the speaker to speak
- Remove distractions
- Empathize
- Be patient
- do not be prejudice
- Understand the tone of speaker
- Do not respond spontaneously. Keep a wait and watch policy
- Understand the idea behind the words of speaker

(b) **Verbal communication:** discussed in lesson 3.

Non-verbal communication: it involves the followings points-

- Body movement
- Posture
- Eye contact
- Closeness of personal space
- Facial expression
- Physiological change

(c) **Problem solving and decision making**

In day to day routine of a supervisor, he has to face of lot of difficulties or problems in works. It can be arouse from men, machine, money, time etc. he has to face the problem and solve it efficiently so as to have a successful carrier. These problems' solution can be achieved by making and implementing a proper decision.

- Define the problems
- Evaluate the alternatives
- Select suitable alternative

(d) **Stress Management and Assertiveness:** (Discussed in Chapter -Stress Management)

TYPES OF DECISION

- (i) Programmed & non-programmed decision
- (ii) Major & Minor decision
- (iii) Routine & strategic decision
- (iv) Organizational & Personal decision
- (v) Individual & Group decision
- (vi) Policy & Operational decision
- (vii) Long term, departmental & non-economic

Programmed & Non-programmed decisions

It is the decision which is made according to some rules & regulations etc.

e.g.:- DA to employees

It is the decision which is taken at a disputed situations/ problems etc.

e.g.:- Unexpected break down of a machinery

Major & Minor decisions

Major decisions are those which taken for buying or selling of precious machineries or plants. Minor decisions are those which taken for buying or selling of not too costly items.

Routine & strategic decisions

Routine decisions are those taken during the routine jobs. Strategic decisions are related to various policies. It involves decisions which made for spending organization's money or to decide price of products.

Organizational & personal decisions

Organizational decisions are those decisions which are taken by a manager in his work related to the organization. Personal decisions are those taken in personal life.

Individual & Group decisions

Individual decisions are taken by a single person keeping in mind that the rules are followed. Group decisions are those which are taken by a group or panel of people.

Policy & Operational decisions

These are the decisions taken by higher management of organization. Operational decisions are those which are taken by the middle management.

Long term, departmental & non-economic decisions

Long term decisions are those which are taken for a long duration. Departmental decisions are taken by any department of organization. On-economic decisions are those which are related to morality/ moral behavior.

PROCESS OF DECISION MAKING

This involves the following:

- a) Define problem
- b) Analyzing problem
- c) Develop the alternative
- d) Choose the best alternative
- e) Converting the decision into effective action
- f) Implementing & verifying the decisions

Define the problem: Managers or supervisors will meet with many problems like increase in cost of production, decreasing sales etc. in these situations one have to take decisions by keeping in mind the organization's interest/policy. Before any such decision making, identify the problem.

Analyzing the problem: Learn the problem carefully and analyze what kind of problem is and who is responsible for solving it.

Develop the alternative: Find out all possible alternatives for solving and note it down. Also analyze the effect of each alternatives effect on the organization.

Choose the best alternative: From all possible alternatives, choose the apt alternative so that the work can be done with limited time and high profit.

Convert the decision into effective action: While directly choosing the solution, involve all of them who are involved in the work. This will make easy to attain a unique solution. Once all the workers involved studies/understand the solution to the problem, the work can be started.

Implementing and verifying the decisions: Once the work started according to the solution/decision, the supervisor has to ensure that the method evolved is being followed on job.

ENERGY CONSERVATION

Energy conservation refers to reducing energy through using less of an energy source/service. It has also effect on nature. Energy conservation reduces the atmospheric pollution as it reduces the usage of energy services.

Considering the necessity of energy conservation, 14 December of every year is celebrated as energy conservation day. If we do not reduce /regulate the utilization of energy sources, it will end up with in few years and will cause huge energy prices.

ENERGY SAVING TIPS:

30% energy needs of a country is for domestic usage. So energy saving should begin at home. Below mentioned are common techniques.

- While building home, proper ventilation should be ensured.
- Window should be provided in such a way that the natural light illuminates inside of house.
- Use light coloured paint inside the house.
- Use light coloured curtains on windows.
- Switch off all electric equipments when not in use.
- Clean up all the illuminating equipments.
- Use energy saving CFL instead of conventional incandescent.
- Use electronic cokes/ballast.
- Use electronic regulators.
- Place exhaust fan above ceiling fans.
- Use automatic iron box for ironing clothes.
- Set geyser temperature at 120°F.
- Before igniting the stove, be ready for cooking and ensured all items are ready.
- Ensured that gas stove burner is clean and the flame is blue in colour.
- While cooking, close the utensils with lids.
- Do not boil/heat up the things directly after taking out from refrigerator.
- Use solar water heaters.
- Unplugged the chargers when not in use.
- Keep good clearance between fridge and wall.
- Do not set too low temperatures in fridge.
- Ensured that fridge door is air tight.
- Always keep fridge door is closed.
- Do not keep hot materials in fridge.
- Use timers on washing machines.
- Use hot water for washing dirty clothes.
- Use adequate water and soap powder.
- Use automatic cut off in AC.

SAVING ENERGY ON ROAD

- Use more energy efficient vehicle or methods for transportation.
- Try not to travel while heavy traffic occurs.
- Use cycle or walk for shorter distances.
- Turn off vehicle at signals.
- Maintain required air pressure inside tyres.
- Carry out regular maintenance services.
- Do not travel on irregular roads.
- Shift gear according to speed of vehicle.
- Do not use brake frequently.
- Do not drive on half clutch.
- Do not overload the vehicle.
- Replace fuel & oil filters yearly.
- Replace engine oil & gear oil regularly.
- Close windows while using AC or heaters.
- Do not drive continuously.
- Turning off AC while travelling save 20% fuel & energy.
- Buy energy efficient vehicles.

ENERGY SAVING TIPS IN WORKSHOP/ OFFICE

- Buy energy efficient equipments.
- Buy BEE certified equipments.
- Use both side of paper.
- Implement paper less working.
- Turn off equipments which are not in use.
- Use natural ventilation and lighting.
- Stop water leakage from pipes.
- Stop air leakage from compressed air lines.
- Engage trained workers on machines.
- Machines are to be used according their efficiencies.
- Reduce idle time of machines.
- Turn off computers when not in use.
- Display posters on energy saving tips.
- Conduct energy audit.

ADVANTAGES OF ENERGY CONSERVATION

- Control spendthrift
- Increases productivity and profit
- Helps in development of nation
- Preserves nature
- Less stress
- Fuel for future generations.
- Increases savings.

ROLE OF VIGILANCE

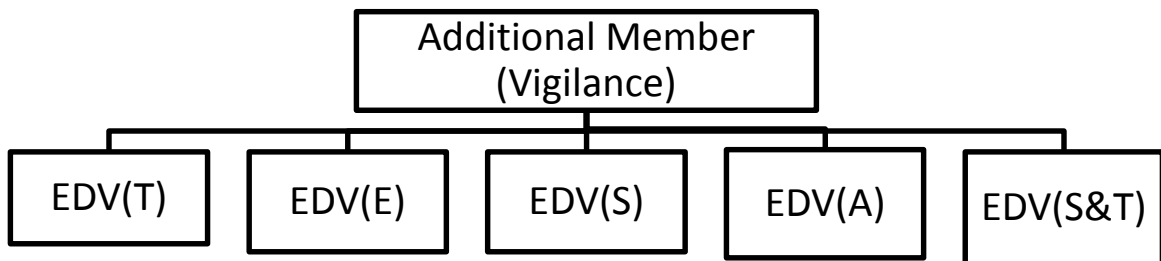
CENTRAL VIGILANCE COMMISSION was established in 1964 by the government of India. The main objective is of CVC is to stop bribery and corruption in government sector. It is an institution under governance of central government.

First CVC was N. SHRINIVASA RAO. This commission submits an annual report to the central government of India regarding the jobs done by CVC and the corruption in various departments of government.

CVC carries out their work through CBI or a **CHIEF VIGILANCE OFFICER**. Chief vigilance commissioner and vigilance commissioner are appointed by president of INDIA.

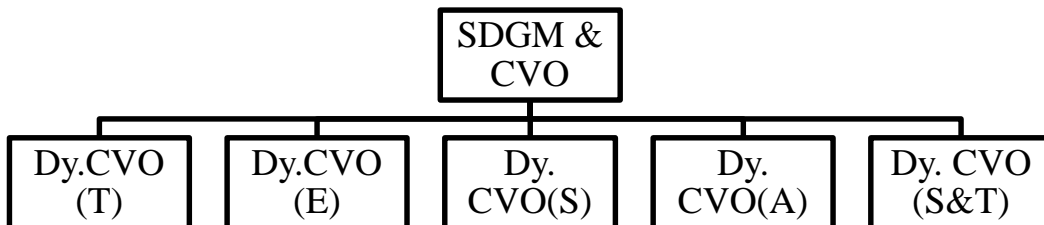
VIGILANCE DEPARTMENT

In INDIAN Railways vigilance department is under member vigilance in Railway Board.

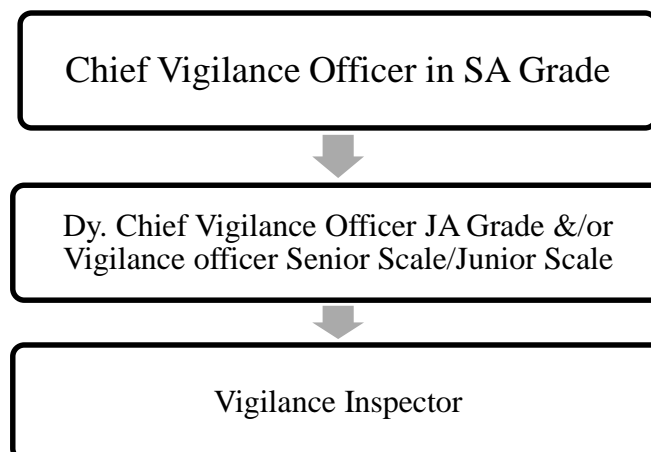


VIGILANCE DEPARTMENT AT ZONAL LEVEL

SDGM heads the vigilance department at zonal level.



ORGANIZATION OF VIGILANCE DEPARTMENT IN PRODUCTION UNITS/OTHER UNITS



VIGILANCE BULLETINE

It is issued twice yearly by Railway Board.

VISION OF VIGILANCE DEPARTMENT

- Bribery
- Partiality
- Differentiating Mentality

Above said points/ factors are considered while vigilance department working. If any kind of complaint is received by vigilance, they act upon it suddenly and the culprit will get punished immediately.

DUTIES OF VIGILANCE DEPARTMENT

- Conduct enquiry on complaints related to corruption and bribery.
- Enquiry on serious unlawful activities.
- Speedy closure of vigilance cases.
- To check whether charge sheet is made properly and no loopholes are left.
- Ensure that D & AR enquiry is being conducted properly.
- Helping CBI with providing data.
- Develop secret services so as to get news regarding corruption.
- Keep an eye on concern officers and employee.
- To understand and feedback with suggesting related to Railway rules and working.

Below mentioned are directions from the vigilance department to the worker:

- Do not misuse Railway's privileges.
- Do not misuse Railway's assets.
- Follow Railway conduct rules.
- Do not misuse your post & powers.
- Do your duty properly.
- Obey establishment rules.
- Do not use short cut methods of working.
- Provide data to vigilance on demand.
- Do not tamper the documents.
- Do not involve in corruption.
- Motivate loyal workers.
- Keep record of all your works.
- Be loyal and trustful to your job.

INDEX
WELDING AND NDT

S. No	Description	Page No	
		From	To
1	Introduction	83	83
2	Definition of Definition terms	84	85
3	Welding Method	86	90
4	CO ₂ / MIG Welding	91	94
5	TIG Welding	95	96
6	Resistance Welding	97	103
7	Plasma ARC Welding and Cutting	104	107
8	Metallurgy of Welding	108	108
9	Non Destructive Testing	109	111
10	Welding Defect	112	112
11	Welding Safety	113	113

INTRODUCTION

Welding is the process of joining two pieces of metals by application of heat. The heat may developed in several ways, along with the application of heat, in some way pressure is also applied in order to have better action of joining. For additional strength, sometimes filler material is also added. It is very old and this is started with joining of two metals by heating them to a very high temperature and then hammering. The various ways of applying pressure in order to affect welding are hammering and rolling.

In welding without the application of pressure the metals are brought to fluid state and joined by some filler materials. This is the most rapid and the easiest way of fabrication and assembly of metal parts. The research carried out in this field has given various ways and method to weld practically all metals. Devices have also been found out to weld dissimilar metals.

Most important quality of welding as compared to other methods of joining is in this process we can have more than 100% strength of joint and it is a very easy process.

It is divided into two main sub-classes:

- 1) Plastic Welding
- 2) Fusion Welding

Plastic Welding

In this process the piece of metals to be joined are heated up to the plastic state and then forced together by external pressure without addition of filler material. e.g. Forge welding, Resistance Welding, Thermit Welding etc.

Fusion Welding

In this case, the metal at the joint is heated to its molten state and allowed to solidify. In this case filler material is used during welding process. E.g. Gas welding, arc welding, Thermit welding.

Advantages of welding

- A good weld is as strong as base metal.
- General welding equipments are not very costly.
- Portable welding equipments are available.
- Welding permit considerable freedom in design.
- A large number of metal/alloys both similar and dissimilar can be joined by welding.
- Welding can join work piece through spots as and in number of other configurations.
- Welding can be mechanized.

Disadvantages of welding

- Welding creates harmful radiations (light), fumes and spatters.
- Welding results in residual stresses and distortion of work piece.
- Jigs and fixtures are generally required to hold and position the parts to be welded.
- Edge preparation of work piece is generally required before welding them.
- A skilled welder is a must to produce the good welding job.
- Welding heat produce metallurgical changes.
- A welding joint for many reasons require stress relief heat treatment.

DEFINITIONS OF WELDING TERMS

Alternative current or AC: -In this kind of electric current, polarity of the current changes its directions from positive to negative and from negative to positive 50times in a second.

Direct current or DC: - Electric current which flows only in one direction.

Arc Voltage:-The voltage across the welding arc.

Open circuit voltage: - The voltage between output terminals of welding machine when no current is flowing in the circuit.

Base weld: - The metal to be welded, brazed, soldered or cut.

Flux:-A fusible material or gas used to dissolve and prevent the formation of oxides, nitrites or other undesirable inclusions formed in the weld metal.

Bevel:- an angular type of preparation .

Weld:-A localized merger of metal or non-metal either by heating the material to welding temperature, with or without the application of pressure and with or without the use of filler materials.

Fillet weld:-A weld of approximately triangular cut section, joining to section approximately at right angle to each other.

Groove weld:-A weld made between to member to be jointed. The standard types of groove welds are as follows-

- Double – V
- Double –U
- Double –J
- Single – V
- Single – U
- Single – J etc.

Root of weld:-The point at which the bottom of the weld intersects the base metal surface.

Root opening: - The separation between the members to be joined at the root of the joint.

Face of weld: - The exposed surface of the weld.

Weld toe:-The junction of the weld face and base material.

Throat of Fillet Weld:-Shortest distance from the root of fillet weld to be face.

Weld Reinforcement: - It is added to ensure that the net throat of weld is not less than that of plate welded. In fatigue or under vibrations the weld joint has the higher strength.

Penetration: - The distance, the fusion zone extended below the surface of the part or parts being welded.

Heat affected zone:-The portion of base metal which has not be melted but the structural properties of which have been altered by the heat of welding or cutting.

Crater: - A depression at the terminations of the welds.

Post heating: - Heat applied to the work after welding or cutting.

Reversed Polarity: - The arrangement of arc welding load where in the work is of the negative pole and the electrode is the positive pole of the circuit.

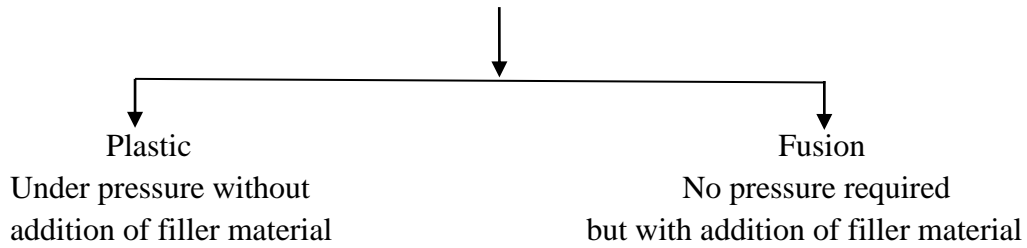
Straight Polarity:-The arrangement of arc welding load where in the work is of the positive pole and the electrode is the negative pole of the circuit.

Tack Weld: - A weld generally of short length made to hold parts to be welded in proper alignment before fully welding.

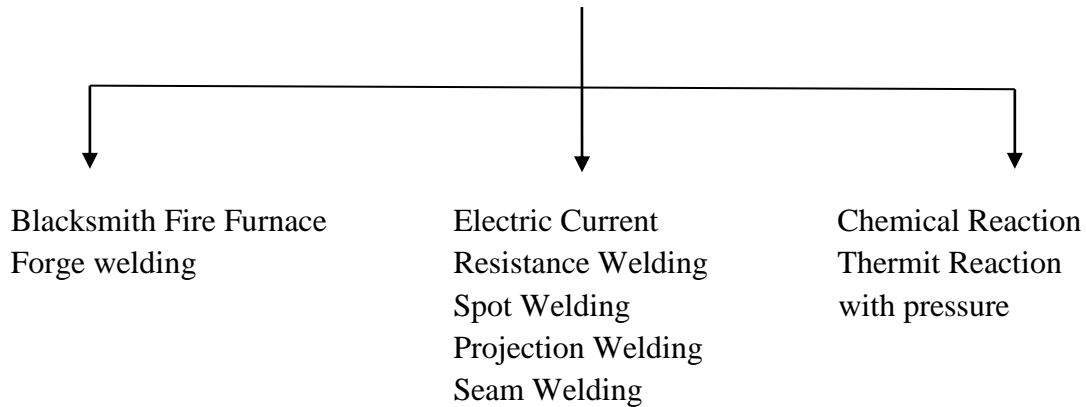
Arc blow: - The deflection of an electric arc from its normal path because of magnetic forces.

Arc Length: - The distance from the end of the electrode to the point where the arc makes contact with work surface.

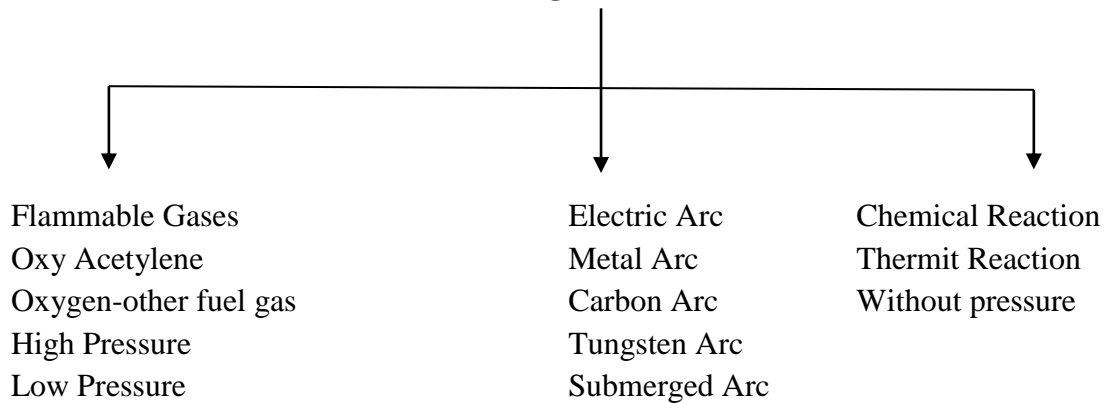
WELDING METHODS



Plastic Welding Method (Heat Generation)



Fusion Welding Method (Heat Generation)



Edge Preparation: For obtaining good results it is necessary:

- It is desirable that two surfaces to be weld should be clean and free from foreign particles/materials.
- The cleaning can be done by wire brushing, machining or sand blasting.
- Impurities of present trend to make the joint weaker as the weld portion is fitted with gas and slag inclusion and metal become brittle and the deposition between the metals is poor.

The various possible edge preparations for butt joints are:

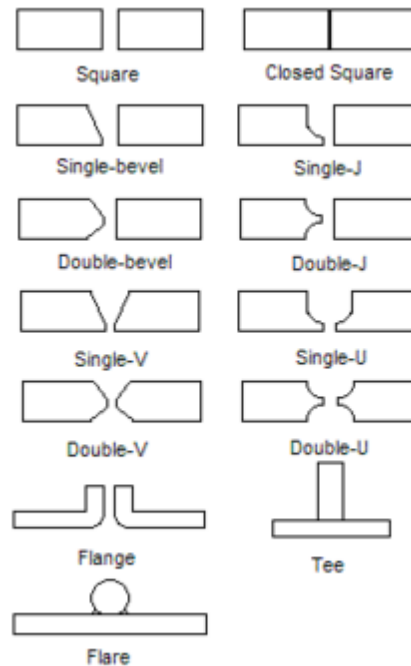
1. Square
2. Single V
3. Double V
4. Single U
5. Double U

In this cleaning of the metal faces from dust, sand, grit, oil and grease is very important.

In square butt weld, the distance between two faces is kept about 3mm and it is used for sheet about 1 to 5mm thick.

Single V and Single U butt weld are used for sheet of about 5 to 15mm thickness. The angle between the edges is kept about 70 to 90 degrees, as depending upon the welding techniques.

Double V and double U butt welds are used for sheet of thickness over 15mm.

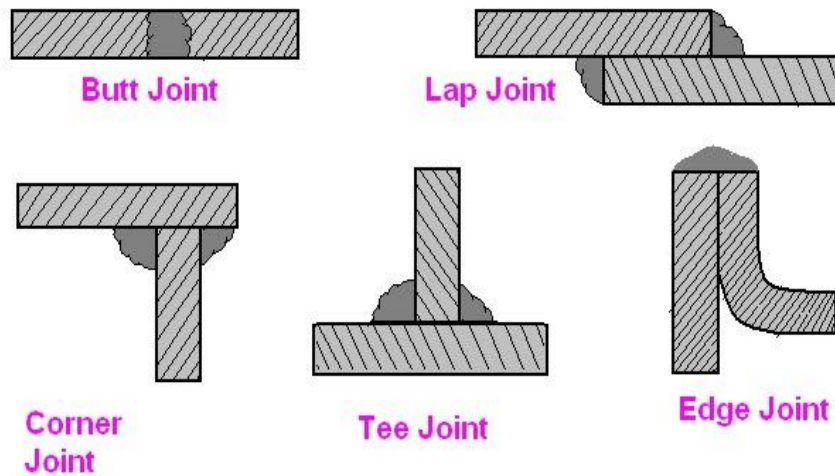


Welding Joints

These types of joints are determined by the relative position of two pieces being joined. There are about five principal types of joints mostly used in welding processes:

- a) Butt joint
- b) Lap joint
- c) T-joint
- d) Corner joint
- e) Edge joint

Welding Joints



Gas cutting: The cutting of metallic sheet by means of oxygen and other fuel gas with the help of cutting torch is called Gas cutting.

Principle of gas cutting: In this method, the oxygen flame heats the metal up to its melting point and convert the metal into oxide. The molten oxide is removed by the gas pressure and the metallic sheet gets divided into two pieces.

There are different methods of oxygen cutting.

- Oxy fuel gas flame cutting
- Metal Powder cutting
- Chemical flux cutting (Injection cutting)

Typed of cutting torches:

- Injection type cutting torch
- Medium or uniform pressure type cutting torch

Welding positions – These are different position of welding

- Flat position
- Horizontal position
- Vertical position
- Overhead position
- Inclined position

Arc Welding

Arc welding tools and equipments

The principal tools and equipments used in arc welding are as follows:

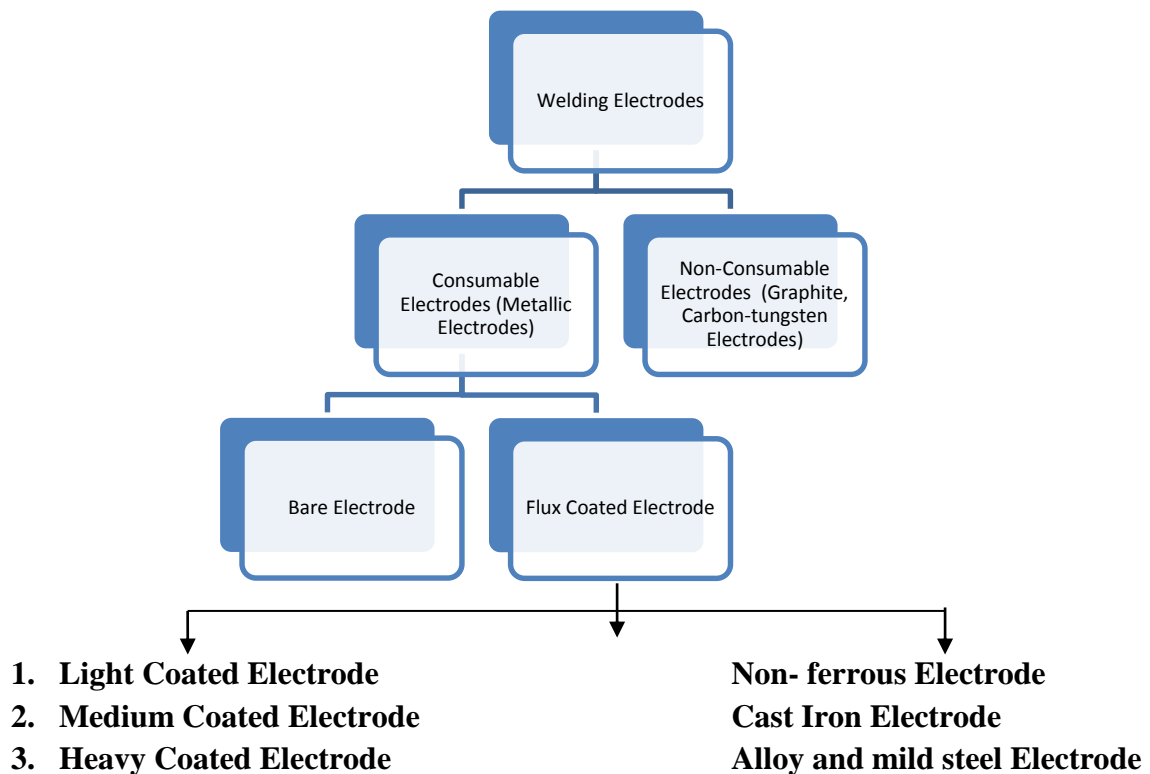
1. Welding machine (DC motor generator, AC Transformer set, etc.)
2. Welding cable
3. Electrode holder
4. Earth clamp
5. Welding table
6. Cable connector
7. Clamp
8. Chipping hammer
9. Welding cream
10. Welding safety goggles
11. Hand gloves
12. Apron, boiler suit
13. Leather safety shoes
14. Hand sleeves

Function of an electrode in an arc welding

The arc welding is done with the help of an electrode. It is metallic bar or wire which carries the current from the electrode holder to the job, the arc is produced by the electrode.

Types of electrodes:

- a) Flux coated electrodes
- b) Bare electrodes



Selection of electrode

Selection of electrodes for particular application is very important to achieve desired properties in the welding joints.

- a) Chemical composition of base metal
- b) Thickness of work piece
- c) Nature of electrode coating
- d) Position of electrode
- e) Type of joints
- f) Type of power sources
- g) Type of polarity
- h) Weld bead geometry and shape of weld bead surface.
- i) Amount of weld metal to be deposited and deposition efficiency of electrodes.
- j) Surface finish and quality of weld metal.
- k) Mechanical and other properties required in the weld joints
- l) Cost of electrodes.

Care and storage of electrodes

Care is required in handling and storage of electrodes. Electrode coating should neither get damped nor be damaged or broken. Electrode with clamp coating will produce a violent arc, porosity and cracks in the joints. Electrode with damaged coating will produce joint of poor mechanical properties. To avoid damage of coating

- a) Electrode during welding should neither bend nor deflected.
- b) Electrode packet should not be thrown or placed over each other.

Electrodes should be stored in dry and well ventilated store rooms. Before use, electrode be dried as per manufacture recommendations. Storage temperature should be about 12 degree Celsius about that of normal air temperature with 0.601 humidity. Cellulose electrodes are not so critical but they should be protected against condensation and stored in a humidity of 90%. All electrodes especially costlier ones should be used till they left hardly 40 to 50mm. Electrodes should preferably be refrained in original packing for identification. Electrodes may be dried at 150 degree Celsius for one hour before use.

CO₂ AND MIG WELDING

CO₂ Welding

Introduction

MIG (CO₂), MAG welding is a variation of the standard MIG process. In MIG process, generally argon, helium or their mixture are used for shielding the molten weld pool whereas in CO₂ welding process, CO₂ is used as the shielding gas.

- CO₂ being an active gas, this process is known as MAG process.
- CO₂ welding is used for welding of carbon and low carbon sheets from 16 gauge (0 to 0.54 inch) to ¼ inch.
- It produces deeper penetration than argon.
- CO₂ have become widely popular for arc shielding or welding of sheets.
- CO₂ is basically a semi automatic process, in which the arc length and the feeding of electrode wire into the arc automatically controlled.
- Less skilled welding is required in compare to TIG and SMAW produced.
- CO₂ may also be used in mechanized and automatic forms where productivity is to be increased and consistent quality in weld object is demanded.

Welding Equipments

- A DC power source and controls.
- A wire feeder which consists of DC motor, speed reduction box, 2/4th roll drive, gas solenoid valve, and potentiometer.
- The welding gun.
- Shielding gas
- Gas pressure regulator
- Flow meter
- Control cable
- Welding cable
- Hoses for gas and water
- Gas pre heater
- Welding helmet
- Gloves
- Apron
- Anti spatter spray etc.

Welding procedure

- Correct edge preparation and joint fit up.
- Joint surface to be cleaned of rust, scale, grease or any other foreign matter.
- Assembling the weld equipments and setting the welding parameters.
- Selecting correct gun nozzle size.

- Setting electric extension on the bases whether short circulating or spray type welding is to be done.
- Passing on the CO₂ gas supply to remove air from the holes and then setting CO₂ flow rate as per base metal and joint design.
- Fillet, vertical, horizontal and over head welds can also be made using CO₂ welding.
- After the weld is complete the end crater should be filled.

Advantages

- Higher welding speed.
- Better and deep joint penetration with good bend control and little tendency to undercut as compared to argon.
- Sound weld deposits which can be made consistently.
- Lower associated cost as CO₂ is relatively inexpensive.
- Despite the oxygen in CO₂, porosity is not a issue when a suitably deoxidized wire (electrode) and reasonably short arc used.
- Good mechanical properties.

Disadvantages

- CO₂ produces a rather harsh arc.
- Spatter is expensive unless a very short, uniform arc length is maintained keeping the tip of the electrode below the surface of the work properly adjusting the power supply. Inductance setting also minimize spatter.
- High impact properties in weld metal cannot be achieved.

METAL INERT GAS ARC WELDING (GMAW)/ MIG

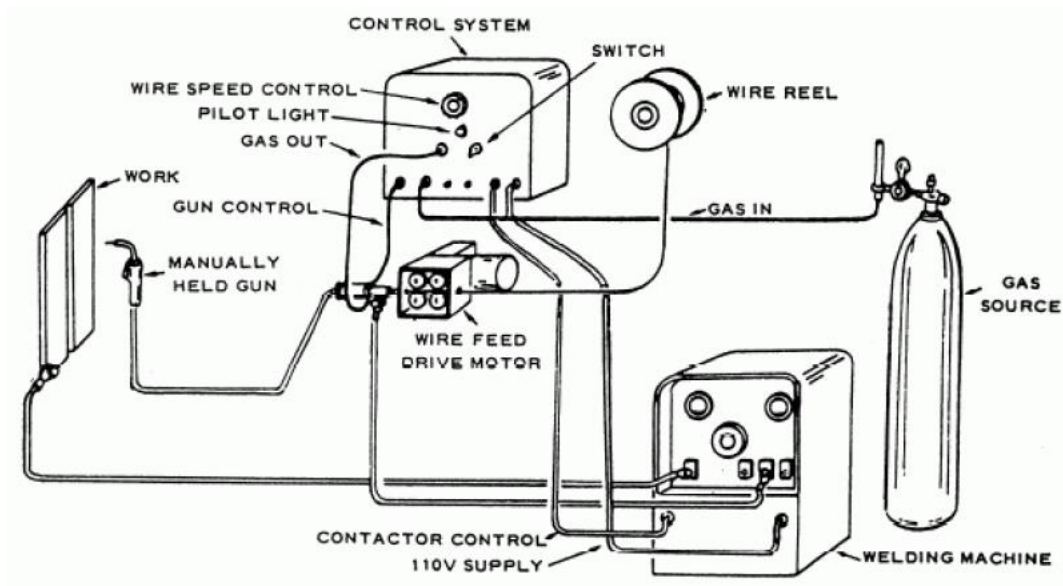
Introduction: - It is an arc welding process where in coalescence is produced by heating the job with an electric arc established between continuously fill metal electrode and the job. No fluxes is used but the arc and the molten metal arc shielded by an inert gas , which may be argon ,helium, carbon dioxide or a gas mixture.

Principle of operation: - Before igniting the arc, gas and water flow is checked. Proper current and wire feed is set and the electrical connection are ensured. The arc is strike by any of the two methods.

In the first method, current and shielding gas is switched ‘on’ the electrode is scratched against the job as usual practice for striking the arc.

In the second method, electrode is made to which the job is retracted and then moved forward to carry out welding, but before striking the arc shielding gas, water and current is switched on. About 15 mm. Length of the electrode is protected from the torch before striking the arc during welding, torch remain about 10 to 12 mm away from the job and arc length is kept between 1.5 to 4 mm.

Arc length is maintain constant by using the principle of self adjusted arc and self controlled arc in semiautomatic welding and automatic welding sets respectively.



Equipment

- a) A welding power source and cables
- b) Welding torch and wire electrode coiled on a spool
- c) Wire feed mechanism and controls consisting of a pairing driving roll, electric motor
- d) Shield gas cylinder, pressure regulator and flow meter.
- e) Controls for switching ON and OFF the current, electrode wire and inert gas.

Metals that can be welded by MIG

- Carbon and low alloy sheets
- Stainless steel
- Heat resisting alloys
- Aluminum and its alloys
- Copper and its alloys
- Magnesium alloys

Joint Design

MIG welding is applicable to following joints

- Butt Joint
- Lap Joint
- Corner Joint
- Edge Joint
- T joint

Advantages of MIG

- Because of continuously feed electrode, MIG welding process is much faster as compared to TIG or stick electrode welding
- Produce joints with deep penetration
- Thick and thin type of work pieces can be welded effectively
- Large metal depositions rates are achieved by MIG welding process
- The process can be easily mechanized
- No flux is used, MIG welding produces smooth neat and clean and spatter free welding surface which requires no further cleaning and hence welding cost reduces.
- Higher arc travel speed associated with MIG welding reduces distortion considerably.

Disadvantages of MIG

- The process is slightly more complex as compared to TIG or stick electrode welding because number of variable like electrode stick out, torch angle, welding parameters etc. are required to be controlled effectively to achieve good results.
- Welding equipment is more complex, more costly and less portable.
- Since air defect may disperse the shielding gas, MIG welding may not work in outdoor welding applications.
- Weld metal cooling rates are higher than the processes that deposits slag over the weld metal.

Applications of MIG:-

- The process can be used for welding of carbon, silicon, alloy steels, stainless steel, aluminum, magnesium, copper, nickel and their alloys.
- For welding tool sheets and dies.
- For the manufacturing of refrigerator parts.
- It is being used in the industries like craft, automobile, pressure vessels etc.

TUNGSTEN INERT GAS ARC WELDING (TIG)

Introduction: - it is an arc welding process where in coalescence is produced by heating the job with an electric arc established between tungsten electrode and the job. A shielding gas is used to avoid atmospheric contamination of the molten weld pool. A filler metal may be added, if required.

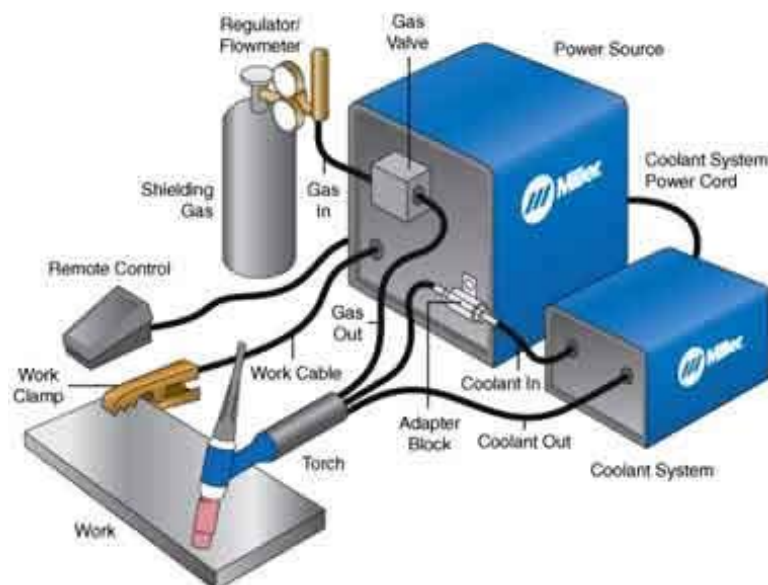
Principle of operation:-Welding current, water and inert gas supply are turned on. The arc is struck either by touching the electrode with a scrap metal tungsten piece or using a high frequency unit.

In the first method, arc is initially on a scrap metal piece and then broken by increasing arc length. This produce repeated twice or thrice warm ups tungsten electrode. The arc is struck between the electrode and pre cleaned job to be welded. This method avoids breaking electrode tips, job contamination and tungsten loss.

In the second method, a high frequency current is superimposed on the welding current. The welding torch is brought nearer to the job. When electrode tip reaches within a distance of 2 to 3 mm from the job, a spark jumps across the air gap between the electrode and the job. The air path gets ionized and the arc is established.

1. Weld puddle is developed due to arc action on job.
2. Welding torch is moved back
3. Filler rod is moved ahead and filler metal is added to the weld puddle.
4. Filler rod is withdrawn.
5. Torch is moved to the welding edge of the puddle.

Note: job before welding is cleaned off from oil, grease, paint, rust etc. either mechanically or chemically.



Equipment

- a) Welding power source, high frequency unit, DC suppressor unit and cables
- b) Welding torch, tungsten electrode, filler material
- c) Inert gas cylinder, pressure regulator and flow meter.
- d) Cooling water supply.
- e) Water and gas solenoid valves.

Advantages of TIG

1. No flux is used, hence there is no danger of flux entrapment; when welding, refrigerator and AC components
2. Because of clear visibility of arc and the job, the operator can work easily
3. This process can be weld in all positions and produce smooth and sound weld with less spatter.
4. TIG welding is very much suitable for high quality welding of thin materials (too thin as 0.125mm)
5. It is very good process for welding non ferrous metals and stainless steel.

Disadvantages of TIG:-

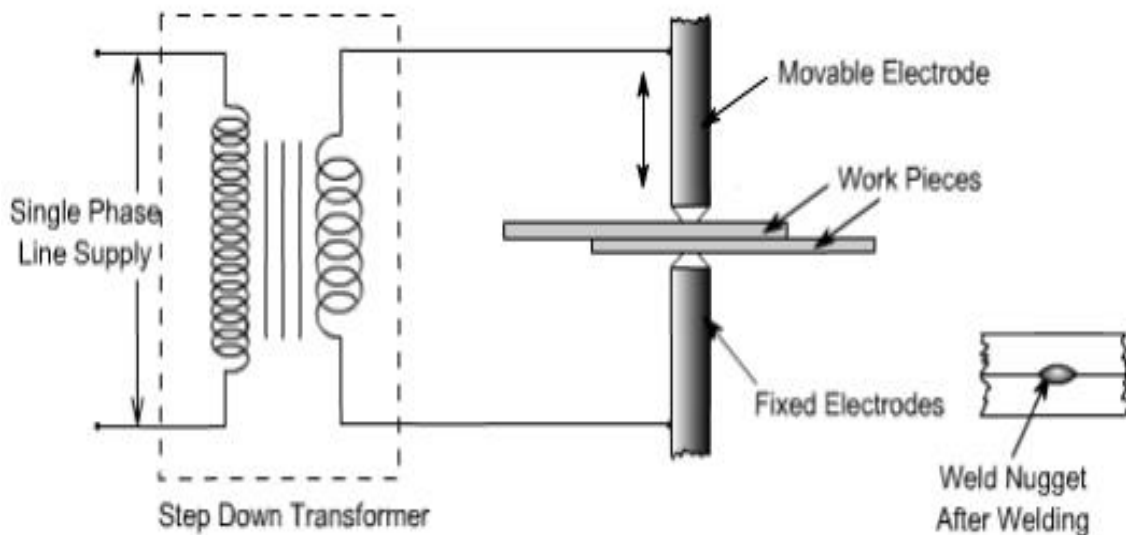
1. Under similar applications MIG is much faster process as compared to TIG welding, since TIG requires a separate filler rod.
2. Tungsten if it transfers to molten weld pool can contaminate the same. Tungsten inclusion is hard and brittle.
3. Filler rod end of it by chance come out of the inert gas shield can cause weld metal contamination.
4. Equipment cost is higher than for shield metal arc welding.

Applications of TIG:-

1. Welding aluminum, magnesium, copper, nickel and their alloys, high temperature and hard surfacing alloys like zirconium, titanium etc.
2. Welding sheet metal and thinner sections
3. Welding of expansion bellows, transistor cases, instruments, diaphragms and cam-sealing joints.
4. Precision welding in atomic energy, aircraft, chemical and instrument industries.
5. Motor chamber fabrication in launch vehicles.

RESISTANCE WELDING

In this metals are joined by the application of heat which is produced by the electrical resistance generated between work piece and electrode. No filler material is used in this kind of welding, but use of pressure (mechanical) is done, while joining metals. In this welding two electrodes of low resistance i.e. copper electrode are used. The work piece is kept between the two electrodes, which complete the circuit.



The resistance of work piece is far more than that of the electrodes thus a high resistance path is created for current flowing in circuit which in turn lead to generation of high heat and it leads to formation of weld pool.

The heat generated during the process can be calculated by-

$$H = I^2RT$$

H = heat generation,

I = Current,

R= Resistance,

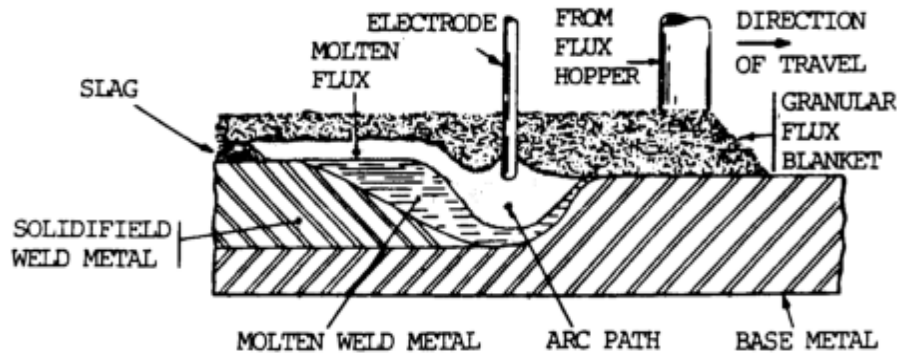
T = time

Submerged arc welding

Introduction: It is an arc welding process where coalescence set up between base metal electrode and the job. The arc, end of electrode and molten metal pool remain completely hidden and are invisible being submerged under a blanket of granular material (flux). The continuously feed base metal electrode melts and acts as a filler metal rod. No pressure is applied for welding process.

Principle: In submerged arc welding process, instead of a flux, covered electrode, granular flux and a base electrode is used. Arc between the job and the electrode is the heat source

and remain buried under the flux. The flux serves as a shield and protects the molten weld pool from atmospheric contamination.



Equipment:-

- 1) Welding leads to feed flux and as filler metal to joint.
- 2) Flux hopper – it stores the flux and controls the rates of flux deposition on the joint.
- 3) Welding power source.
- 4) Flux.
- 5) Electrodes.

Operation:-

- Trigger is pulled and the flux shoots depositing on the joint to be welded.
- The arc may be struck either by touching the electrode with the job or by placing steel wool both electrodes and the job before switching on the welding current.
- In all the cases the arc is struck under a cover of flux.
- Flux is insulated but become highly conductive so current passes between electrode and job.
- The electrode of a predetermined speed is continuously fed to the joint.
- The arc length is kept constant.
- Producing plate of steel or copper may be used to control penetration and to support large amount of molten metal associated with the process.

Advantages:-

- Molten flux provides suitable condition for high current flow.
- Higher welding current may be used.
- Due to high heat concentration and faster welding speeds, weld destruction is much less.
- High metal deposition rate can be achieved.
- Welding is carried out without sparks, smoke, flash and spatter.
- Uniformity, good conductivity, corrosion resistance and good impact strength can be achieved.
- It can be used for welding in exposed area with relatively high winds.
- No edge production required for materials under 12 mm thickness.

Disadvantages

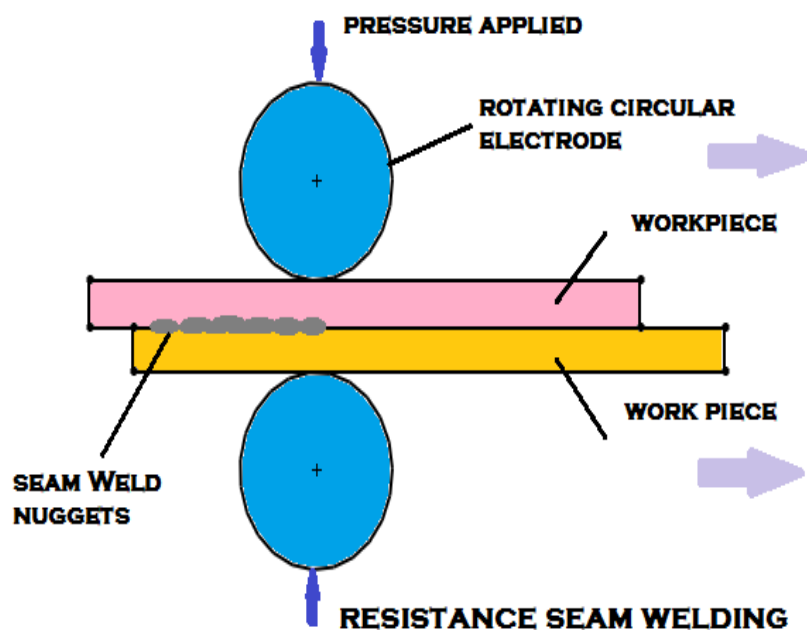
- Cannot judge accurately the process of welding , so extra equipment like jig, fixtures, painter, light beam etc. required
- The flux always needs preplanning of the same on the joint.
- Possible zero welding in flat position only.
- Flux may spill through the gap and arc may burn the work piece edges.
- Contaminated flux caused the porosity in welding.
- Weld metal chemistry is difficult to control.
- Cast iron, Al alloys, Mg alloys, Pb and Zn can't be welded by this process.

Application

- Fabrication of pipes, penstocks, pressure vessels, boilers, structural shapes, rotary railroads and earth moving equipment, cranes , bridges, grinder and under structures of railway coaches and locomotives.
- Automobile, aviation, ship building and nuclear power industry.
- Rebuilding of worn out part and depositing wear resisting alloys, crane pulleys.
- For welding metals like mild steel, medium and high tensile low alloy steel.

Seam welding

Introduction: - it is a resistance welding process where coalescence at the facing surface is produce by heat obtained from resistance, electric current (flow) through the work parts held together under pressure by the electrodes .the resistance weld is a series overlapping resistance, spot welds made progressively along a joint by rotating the circular electrode.



Methods of seam welding

- One involves continuous motion.
- The other intermittent motion during welding operation
 - In continuous motion method, the electrodes rotate at a constant speed and the current flow continuously or interrupted.

- In the intermittent motion welding, the electrode travel the distance necessary for each successive weld and then stop. The current is then switched on and the weld made. The whole process being controlled automatically.
- In continuous motion welding work piece is less than 4.5mm thickness.
- In intermittent motion above 4.5mm thick job is done.

Seam welding equipment

- 1) Power supply
- 2) Electrode force and support.
- 3) Electrode or work drive.

There are three general types of seam welding machines.

1. **Circular:** - In which the faces of the electrode wheels are at right angle to the throat of this machine. This machine is used for circular work, such as welding the continuous or for flat work requiring long seams.
2. **Longitudinal:** -In which the faces of electrodes of what are parallel to the throat of the machine and throat depth is typically 30cm to 90cm. This machine is used for welding short seams in containers.
3. **Universal:** - in which the electrode wheels may be set in either the circular or longitudinal position by the use of swivel type upper head in which the upper wheel ends its bearing can be swiveled 90 degrees. The lower mounting may consist of two interchangeable lower arms or both may be attached permanently to the machine. By means of hinges or a swinging column, so that either may be swing into place.

Metals Welded

- Low carbon, high carbon and low alloy steels.
- Stainless and many coated steels.
- Aluminum and its alloys.
- Magnesium alloys.

Advantages

- It can produce gas tight or liquid tight joints.
- Overlap can be less than for spot or projection welds.
- Single seam weld or several parallel seams may be produced simultaneously.

Disadvantages

- Welding can be done only along a straight or uniformly curved line.
- It is difficult to weld thicknesses greater than 3mm
- A change in the design of electrode wheels is required to avoid obstruction along the path of wheel during welding.

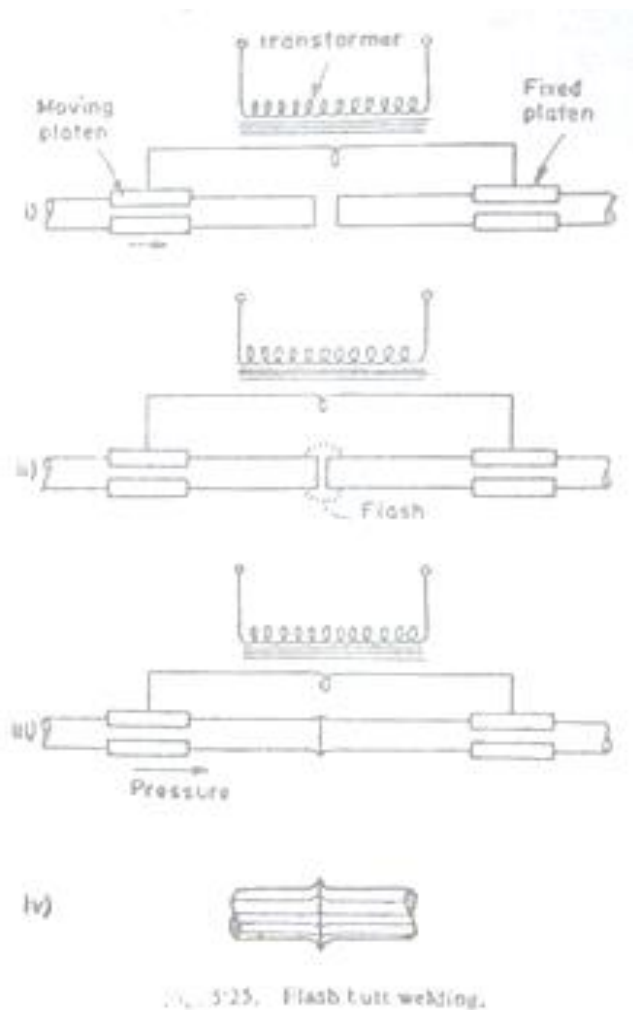
Application of Seam Welding

- Gritweld can be done in round, square or rectangular parts.
- Except for copper and high copper alloys, most other metals of common industrial use can be seam welded.
- Besides lap welds, seam welding can be used for making butt seam welds too.

Flash Butt Welding

Introduction: - The term flash welding derived its name from the flash produced during the process. Probably, flash welding process was developed from resistance butt welding by accident it attempts to increase the capacity of butt welding machines by raising the voltage and apply pressure intermittently.

Definition :- flash welding is a resistance welding process where in coalescence is produced, simultaneously over the entire surface of a butting surface, by the heat obtained from resistance to electric current between two surface substantially completed. Flashing and upsetting are accomplished by expulsion of metal from the joint.



Operation: - The sequence of operation required for flash welding given below:

- Flash butt weld are made on a machine having one stationary and one opposing movable plates on which flash welding dies and clamps are mounted.

These clamps separately held the two work pieces to be welded while simultaneously serving to conduct the welding current through the work pieces.

- The work piece held is a movable pattern is brought toward the one gripped in the stationary platen until the two come in light contact & as the welding current is turned on and thus flash is established. The movable plates keeps on moving constantly towards the stationary one at a carefully and accelerate rate.

- As the flashing continues the end of the two work pieces burn off as they reach such a higher and higher temperature until finally they attain the welding temperature.

- At this stage, the pressure of a moving clamp is quickly and greatly increased to (upset) forge the parts together and expel the molten metal and slag out of the joint, thereby making a good solid weld. The metal expelled from a ragged fin or flush round the joint which is removed latter on by cutting or grinding.

Metals welded by flash welding

- Low carbon steel.
- Medium and high strength low alloy steels.
- Tool steels.
- Stainless steel.
- Aluminum alloys (with thickness > 1.25mm).
- Copper alloy (with high zinc content).
- Magnesium alloys.
- Molybdenum alloys.
- Nickel alloys.
- Titanium alloys.

Flash welding equipments

- A main frame.
- A stationary plate.
- A movable platen.
- Water cooled clamps.
- Transformer, as used on other welding machines.
- Tap switch.
- Electrical controls.
- A flashing & upsetting mechanism.

Advantages

- Many dissimilar metals with different melting temperature can be flash welded.
- Flash welding offers strength factors up to 100%.
- Generally no special preparation of the surface is required.
- Flash welding can be used for the welding of those highly alloyed steel which cannot be welded satisfactorily by any other process.
- The process is cheap i.e. the cost of current per weld is small
- Flash welding is faster than many other methods.
- Flash welding gives a smaller upset.

Disadvantage

- The most undesirable feature of flash welding is the flushing operation during which it is impossible to protect the welding machine and the surrounding area from these particles.
- The process presents a considerable fire hazard, operation needs to be protected from flying particles.
- Concentricity and straightness of work piece during welding is often difficult to maintain.
- Metal is cast during flashing and upsetting.
- Shape of the work piece to be flash welded should be similar.

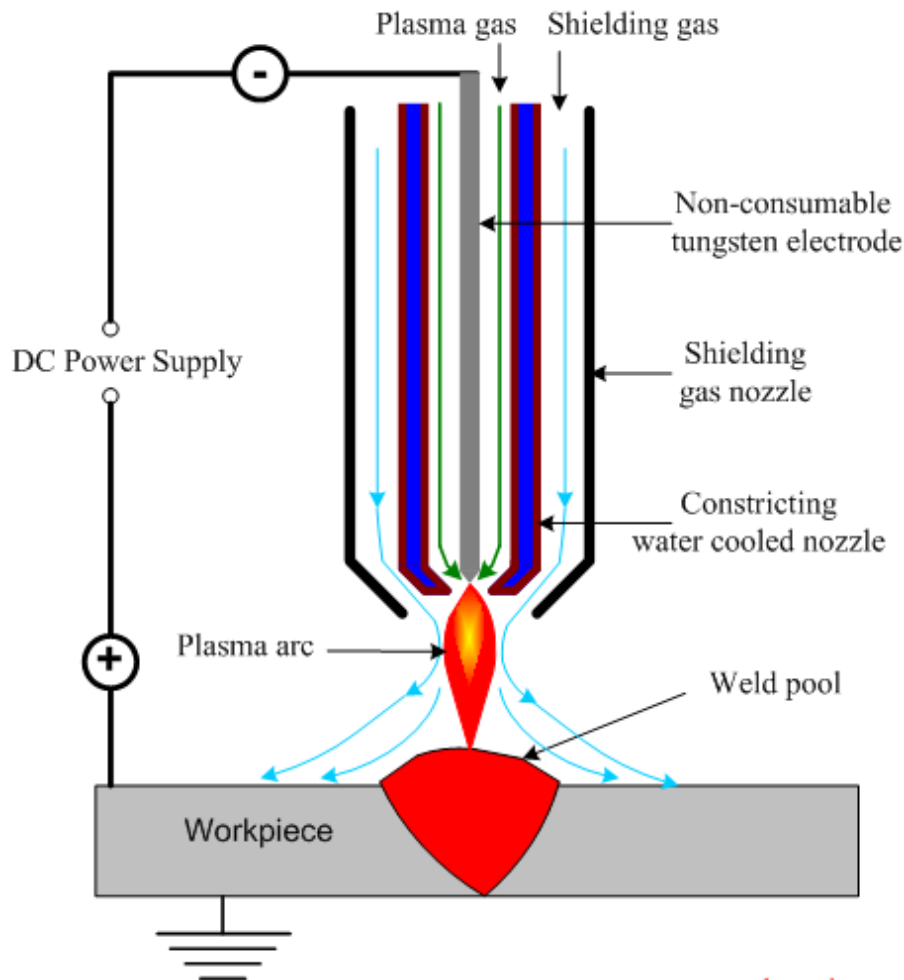
- It is generally not recommended for welding zinc and to alloys cast iron, lead and its alloys.

Application

- Flash welding is applied primarily in the butt welding of metal sheets, tubing, bars, rods, forging, fitting etc.
- Flash welding finds application in automotive and aircrafts products, household appliances, refrigerating and farm equipment.
- The process is also used for welding the band saw blades into continuous loops, and joining of steel drill, tap and reamer, bodies to low carbon steel and alloy steel shanks.
- Flash welding is used to produce assemblies that otherwise would require more costly forging or casting.

PLASMA ARC WELDING AND CUTTING

Definition:- It is an arc cutting process where in the serving of the metal is obtained by melting a localized area with a constricted arc and removing the molten material with a high velocity job of hot, ionized gas issuing from the orifice.



Principle of operation

Plasma arc cutting makes use of DCSP (electrode negative) with a constricted transferred arc struck between tungsten electrode situated within (and not protruding) the torch & the work piece to be cut.

The cutting arc between the electrode and the work piece is initiated by a pilot arc between electrode and the nozzle. The nozzle is connected to ground (+) through a current timing resistor & a pilot arc in contact.

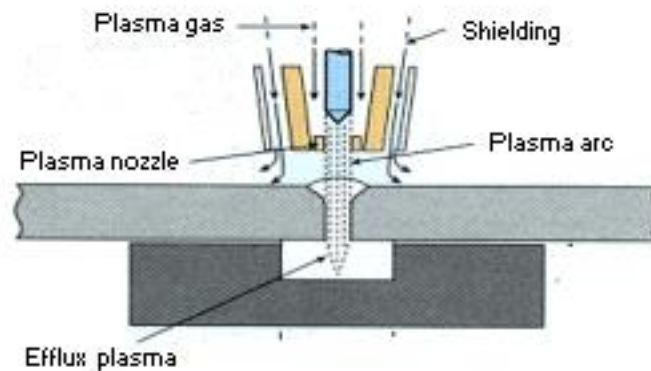
The pilot arc is initiated by high frequency generator connected to the electrode and nozzle ionized orifice gas from the pilot arc is blown through the constructing nozzle orifice. This forms a low resistance path to guide the main arc between the electrode and the work piece. Once the main arc is ignited the pilot arc is ignited the pilot arc goes off.

A high frequency electric arc thus established passed through a stream of inert gas (usually nitrogen) the latter is ionized. Both the ionized gas column and the arc forced through the small orifice in the torch nozzle. The nozzle, having a relatively small orifice,

constricts the arc and thus increases current density and arc temperature. This high temperature arc is localized and concentrated upon a small area of the plate where its intense heat melts the metal to be cut.

- The gas which is heated by the arc cannot expand due to the constriction of the nozzle orifice and it emerges in the form of a supersonic jet.
- The base metal continuously melted by the intense heat of the arc is removed by the jet – like gas stream (issuing from the torch nozzle) to form a narrow kerf and smooth surface.

The combined heat & force of the arc stream produces a high quality, saw like cut.



Cutting torch

- Plasma cutting torch may be either manually operated or machine operated in which case the torch is mounted on an automobile travel mechanism.
- Torch consists of an electrode holder which centers the electrode tip with respect to the orifice in the constricting nozzle. The tip of the electrode within the nozzle. Orifices in the nozzle constrict the arc.
- Plasma arc is injected into the torch around the electrode and it emits through the nozzle orifice.
- The electrode and nozzle are water cooled to prolong their lives.
- Nozzle with varies orifice diameters available. Large diameter orifice is required at higher current.
- Plasma arc cutting makes use of both single and multiple port nozzles.
- Most plasma cutting torches impose a swirl on the orifice gas flow pattern by injecting the gas through tangential holes. gas will help more efficient transfer of arc energy to one side of the kerf with the clockwise swirl the right side of the cut (facing in the direction of travel) will be reasonably square, but the left side will be beveled. Thus select the travel direction such that a scrap material is placed on the lift.

Gas cylinder, regulators, flow meters and gas supply hoses

- N_2 , $N_2 + H_2$ or $Ar + H_2$ mixtures are used for cutting non ferrous metal and stainless steel.
- Carbon steel are cut by using compressed air and nitrogen.

Power source

- Open circuit voltage 100 to 400 volts.
- Current 250 to 1000 Amp.
- Power source with drooping characteristics (DCSP).
- Heavy cutting requires high DC voltage.
- Pilot arc and high frequency power source circuit
- A system to circulate cooling water.

Control

Relay and solenoid valves to turn gases and cooling water on and to operate the high frequency power supply is required for a starting.

Typical Plasma Cutting Parameters

To cut 25 mm thick	Orifice diameter (mm)	Current DCSP (Amp)	Cutting speed (mm/s)	Power (KW)
Aluminum Alloys	4	400	38	80
Stainless Alloys	4	400	21	80
Carbon Steel	4	425	21	85

Metals Cut

- | | |
|-----------------|--------------------|
| I. Carbon steel | V. Stainless steel |
| II. Cast iron | VI. Aluminium |
| III. Magnesium | VII. Nickel |
| IV. Brass | IX. Copper etc. |

Advantages of Plasma Arc welding and Cutting:

- It cuts carbon steel up to 10 times faster than any fuel cutting equality more economically.
- It leaves a narrower kerf.
- Plasma cutting, being primarily a melting process, can cut any metal.
- Arc plasma torches give the highest temperature available from many practical sources. The energy seems to be unlimited in this method.

Disadvantages of plasma arc welding and Cutting:

- A major limitation in implementing a plasma welding process is the relatively high startup costs. Plasma welding equipment tends to be expensive. Because it is a more specialized welding process, the training and expertise required is also more intense.

Application of plasma arc welding and Cutting

- Plasma cutting used to cut particularly those non-ferrous and stainless metals that cannot be cut usual rapid oxidation induced by ordinary flame torches.
- Plasma cutting can be used for stock cutting, plate beveling, shape cutting and piercing.
- With some modifications, plasma arc cutting can be used under water.
- Plasma arc cutting finds applications in many industries such as shipyard, chemical, nuclear and pressure vessel.
- It is used for removing gates and risers in foundry.
- It cut hot extrusions to desired length.
- It is used to cut any desired pipe contour.
- It is also employed for gauging applications.
- It finds use in the manufacture of automobile and railroad components.

METALLURGY OF WELDING, BRAZING AND SOLDERING

The study of welding metallurgy is very useful because of the overall mechanical properties of a weldment are determined by the characteristics of the individual microstructure present in the weld deposit and the weld heat affected zone.

- Weld metal is quickly melted and then it re-solidifies under the equivalent of chill casting conditions.
- Parent metal is subjected to a complex thermal cycle with a temperature gradient extending from the melting range to ambient temperature and followed by a cooling induced by the surrounding cold water.
- Temperature changes and change in micro-structure introduced volume changes in the area surrounding the weld and hence cause straining, plastic flow, residual stress or even cracking.

Welding metallurgy is concerned with

- Melting of electrode and parent metal,
- Solidification of weld metal,
- Gas absorption and gas metal reaction,
- Slag metal reaction,
- Surface phenomena,
- Solid state reaction.

Welding Arc: - A large number of welding processes made use of flame or an electric arc to melt the base metal and the filler metal to the electrode.

Heat flow in and around weld metal:-

- The sufficiently high temperature of the welding arc quickly heat up the base metal and the electrode or filler metal melt to form the molten weld pool.
- For controlling metallurgical events in welding, the thermal condition in and near the weld metal must be established.

Important facts are:-

- The distribution of maximum temperature in the weld heat affected zone.
- The length of time of temperature.
- Cooling rate on the weld metal and in affected zone.
- The solidification rate of weld metal.

Metallurgical effects of welding:-

- Weld metal,
- Absorption of gases by weld,
- Slag inclusion,
- Hot cracking of welds,
- Heat affected zone,
- Corrosion of welds
- Dilution.

NON DESTRUCTIVE TESTING METHODS (NDT)

Inspection of Welding

Inspection necessary on welding: Defective welding reduces the utility of job and it may cause an accident even.

Principal method of Inspection

- a) **Non Destructive Test:** In this test, the job is tested without damaging or destructing it.
- b) **Semi Destructive test:** In this test, a part of the job is damaged which requires repairing.
- c) **Destructive Test:** In this test job gets damaged completely. This test is meant for measuring the mechanical property of the job.

Various types of Non Destructive Test

- a) Visual Inspection
- b) Paraffin Oil test
- c) Magnetic Test
- d) Stethoscope Test
- e) Hydraulic Test
- f) Air test
- g) X-Ray test
- h) Gamma ray test
- i) Ultrasonic test
- j) Dye penetration test

Various types of Semi Destructive Test:-

- a) Cutting test
- b) Acid test
- c) Drilling test

Various types of Destructive Test

- a) Hardness test
- b) Impact test
- c) Bending test
- d) Tensile test
- e) Neck Break test

Non destructive test

It may be used to detect defects that would be difficult or impossible to detect by visual examination. The techniques are used during manufacturing as a quality control tool to determine the quality of work. The intent of NDT depends upon the application and criticality of the joint is generally specified in the relevant application standards or contract specifications. It is important for NDT to be included in the planning of the fabrication process as it can require substantial time and resources. Full account of this must be taken in description of production and delays to the programme are to be avoided.

The requirement to perform NDT must also be taken into account during the design phase. As with welding, access for NDT must be planned into the component. The

application of this is that both welding engineer and designer must be conversant with the techniques and their limitations if the processes are to be used effectively.

Dye Penetrate examination

This is a technique that is capable of detecting surface breaking defects only. It relies upon a colored or fluorescent dye sprayed upon the surface, penetrating these defects. After cleaning the excess from the surface by spraying on a developer in the case of the colour contrast dye or by exposing the surface to ultraviolet light. The defect is revealed by the dye straining the developer or by fluorescing.

The fluorescent dye gives greater sensitivity than the color contrast dye. It does requires the use of an UV light and preferably a darkened room. It must be capable of penetrating narrow cracks. It must be high contrast with the developer. It is also important that the test piece is thoroughly pre-cleaned. Degreasing should also be carried out.

Advantages

- It can be used on both ferrous and non-ferrous materials.
- It is very portable.
- Large area can be examined very quickly.
- It can be used on small part with complex geometry.
- It is simple, cheap and easy to use and interpret.

Disadvantages

- It will only detect defects open two surface.
- It is not possible to retest a component indefinitely.
- Careful surface preparation and cleanness are required.
- There may be health and safety problems with some of chemicals.

Eddy current examinations

It is a process that may be used in any material that will pass on electric current. A coil carrying alternating current is placed close to item to be examined, including an eddy current in the specimen. Defect in the specimen will interrupt this eddy current glow and these perturbations can be detected by second search coil. The equipment is calibrated using a defect free specimen. The accuracy can be affected by metallurgical conditions standoff and coil dimensions for these reasons eddy current testing is used only rarely on welded components. It is of limited use for interrogating welds.

Ultrasonic Examinations

The ultrasonic examination of welds uses the same principle as when sonar is used for the detection of submarines. In welded components this is usually done by moving a small probe, contouring both transmitter and receiver, over the item be examined and displaying the echo on oscilloscope screen. The probe transmits a beam of ultrasonic that passes through metal and is reflected back from any defect.

The success of the technique depends upon the use of the trained experienced operators who knows precisely the characteristics of metal being examined, the beam direction, its amplitude & frequency and the weld geometry. The frequency of ultrasonic waves is generally in the range of 2-5MHz, the lower frequency is used for the detection of fine defects.

Probes can be obtained that project beam into the test piece at an angle, the most common being 45°, 60°, & 70°. The angled probe are best suited for the detection of defects at an angle to the plate surface such as lack of side wall fusion to ensure that all of defects are detected by probe must be scanned over the full cross section & the full length of the weld.

Advantages

- It is very good for detection of planer defects.
- It can easily determine defect depth.
- It is readily portable.
- Access is requiring to one side only.

Disadvantages

- Very skilled operators are required.
- Surface breaking defects are difficult to detect.
- No permanent objective records are available.
- The process can be slow and laborious.

Radiographic examination

Electromagnetic radiation has properties that are useful for industrial radiography purpose. The rays travel in straight lines and can't be deflected or reflected by mirrors or lenses. They have wavelengths that enable the radiation to penetrate many materials.

To radiograph a welded joint a suitable source or radiation a film in a light proof cassette of some method of processing the film are required. This later generally requires a dark room where the film can be developed fixed, washed, dried, and viewed. The radiation can be produced from an X-ray tube, the energy generally being described by the voltage, current at which tube is operated. These may vary from 20mV – 30mV and 10mA-30mA. Although the normal limit for the commonly available industrial unit is around 400 KV. A 400 KV unit is capable for penetrating upto 100 mm of steel sheets.

The quality of radiograph is affected by source of the film distance, the greater this is the sharper the image; the size of radiator source. Higher the energy, the less sharp is the image; film grain size and quality and the correct film processing.

Advantages

- A permanent receiver is available.
- Both buried and surface defects can be detected and the technique is particularly good for finding volumetric defects such as slag and porosity.
- The equipment is portable, particularly the gamma ray source.
- All materials can be examined.

Disadvantages

- The capital cost of equipment includes the processing and viewing qualities.
- Health and safety considerations.
- Access is required to both sides of component, the source on one side, the film on the other.
- There is the limitation on the thickness that can be radio graphed and defects easily detected.
- Skilled and experienced radiographers are required.

WELDING DEFECTS

- a) **Internal Defects:** which are invisible in nature.
- b) **External Defects:** which are visible in nature?

Various types of external defects

- **Spatter:** The deposition of weld metal around the joints in the form of small pills is called spatter defects.
- **Overlap:** The formation of an excess layer bead on the joint is called overlap defect.
- **Undercut:** The defect is reverse to overlap defect. In this defect, deep slot are left behind in the joint.
- **Inclusion:** The presence of foreign material in the weld metal is called inclusion defect.
- **Blow hole:** Large sized holes left behind in the weld bead are called blow holes. They are produced due to gas bubbles.
- **Incomplete Penetration:** Insufficient approach of a weld metal into the joint is referred as incomplete penetration.
- **Crack:** The development of the crack in the weld metal is referred as crack defect. It may be external or internal type. It makes the joint incapable to bear the load.
- **Crater:** The development of the pit at the end of the weld line is called a crater. In order to eliminate this defect the electrode should be kept on the weld line so long as the pit does not get filled completely.
- **Porosity:** The formation of the number of small holes in the weld bead is called porosity defect.
- **Lack of fusion:** The defect due to which the main metal and the weld metal do not mix properly on account of insufficient melting is called lack of fusion.

SAFETY RECOMMENDATION FOR INSTALLATION AND OPERATING OF ARC WELDING AND CUTTING EQUIPMENT ARC

Welding Machines

- Arc welding machines should be of suitable quality.
- Arc welding machine should be properly grounded (earthed).
- Proper terminals should be used on the arced welding machines for the power line voltage connection.
- One should not work on the wiring of an arc welding machines unless qualified to do so.

In the case of AC arc welding machines

- In transformers, the secondary circuit shall be thoroughly insulated from the primary.
- Welding (secondary) terminals shall be so arranged that current carrying parts are not exposed to accidental contact.
- In a transformer the welding circuit should be quite separate from the power circuit, so that there is no risk of worker suffering serious shocks or burns through power voltage appearing across the electrode holder.
- Control apparatus provided with the welding machines shall be enclosed except for the operating wheels, levers etc.
- Transformer welding be suction or compressed air cleaned periodically.
- Greasing points need attention periodically.
- Switch contacts should be cleaned periodically.
- Before under taking any maintenance work on welding machines, disconnect them from the main supply.

OTHER ARC WELDING EQUIPMENTS

Electrode Holder

- Electrode holder should be soundly connected to the welding lead. They should be of adequate rating for the maximum welding currents to prevent them from heating up and becoming too hot to handle.
- Insulation of all metallic and current carrying parts, including the jaws which grip the electrodes, is recommended.

Welding Cables: Welding Cables shall be of completely insulated, flexible type.

- The body or the frame of the welding machine shall be efficiently earthed.
- Earthing cable should be connected to the job as nearest as possible.
- Avoid earthing cable connection at rail lines, wheels, bearings, CBC and other Sensitive parts of coach & wagon.

PROTECTION OF WORKERS: Workers need to be protected from:-

- The welding rays.
- Flying sparks, metal globules (spatter), hot slag particles and hot electrode stubs.
- Fumes and gases when welding in confined space.
- Falling when welding at a height from the ground.

So workers should wear personnel protective equipments (PPE) to protect from hazardous happenings.

INDEX

S No	Subject	Page No	
		From	To
1	Jigs and Fixtures	115	124
2	Gauges	125	130
3	Machine Tools Maintenance	131	133
4	Plant Layout	134	138
5	Process Flow Diagram	139	142
6	Production Planning & Control	143	151
7	Industrial Safety	152	164
8	Material handling	165	166
9	Engineering Drawing	167	168
9	Work order numbering system	169	169

Unit 1 Introduction of Jigs and Fixtures

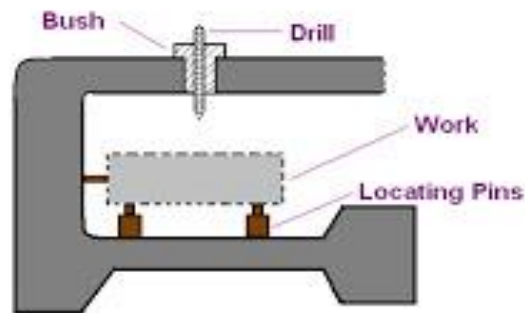
- Some operations are such type in which the tool is required to be guided by means of another device also some jobs are of such forms which are required to be held in position on the machine by means of another device.
- The device which guides the tool is called jig and the device which holds the job in position is called fixture.
- 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 clamped to the machine table. It is usually heavy in construction.
- Jigs are used on drilling, reaming, tapping and counter 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.
- 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 inter changeability part will be produced within an established tolerance.
- A jig may be defined as a device which hold and position the work, locate or guides the cutting tool relative to the work piece usually not fixed to the m/c table.
- It is usually lightly in construction.
- They eliminate the necessity of a special set up for each individual park.

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 interchange ability.
- To enables heavy and complex shaped parts to be machined by holding rigidly to a machine.

- To control quality control expenses.
- Less skilled labour.
- Saving labour.
- There use partially automates the machine tool.
- Improve the safety at work, thereby lowering the rate of accidents.

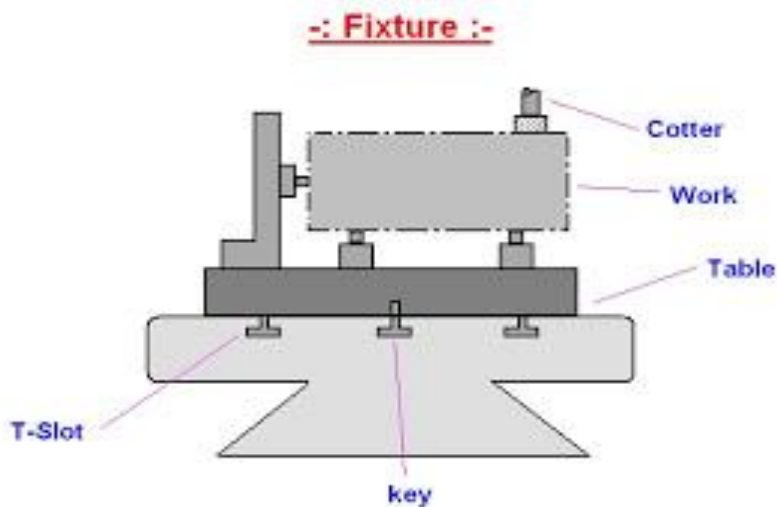
Jigs :-



:- Jig :-

- 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.
- 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.

Fixtures :-



- Fixtures have a much-wider scope of application than jigs.
- These work holders 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 work piece.

Primary purposes of jigs and fixtures :-

- Reduce the cost of production
- Maintain consistent quality
- Maximize efficiency
- Enable a variety of parts to be made to correct specifications
- Reduce operator errors

Design principles Common to jigs and fixtures

There are some principles which are useful to design jigs and fixtures.

1. Rigidity:

Jigs and fixtures should be sufficiently stiff to secure the preset accuracy of machining.

2. Fool proofing:

It can be defined as “**the incorporation of design feature in the jig or fixture that will make it possible to lead the work into jig and fixture in an improper position, but will not interfere with loading and unloading the work piece.**” There are many fool proofing devices, such as fooling pegs, blocks or pins which clear correctly position parts but prevent incorrectly loaded parts from entering the jig and fixture body.

3. Clearance:

Clearance is provided in the jig or fixture body :-

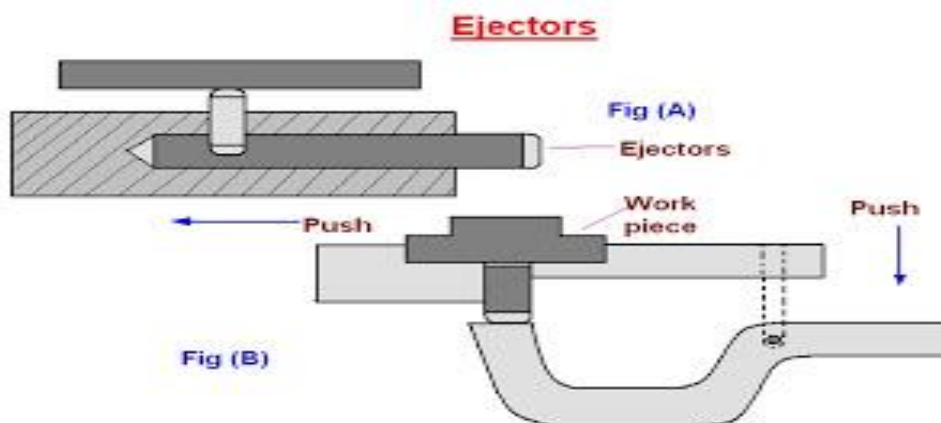
(A) To allow for any variation in component sizes specially casting and forging.

(B) To allow for hand movements so that the work piece can easily placed in the jig or fixture and removal after machining.

4. Burr Grooves:

- A burr raised on the work piece at the start of the cut is termed a minor burr and at the end of a cut is called a major burr.
- Jigs should be designed so that the removal of the work piece is not obstructed by these burrs for this suitable clearance grooves or slots should be provided.

5. Ejectors:



The use of ejection devices to force the work piece out from the jig or fixture is important in two situations:-

(A) The work piece is heavy

(B) Machining pressure forces the work piece to the slides or based on the jig or fixture and the pressure and oil or coolant fill will cause the work to stick and difficult to remove on small jigs and fixtures, a pin located under the work will remove the part radially.

6. Inserts:

To avoid any damage to fragile and soft work piece and also to the finished surfaces of the work piece while clamping. Inserts of some soft material such as copper, lead, fiber , leather , hard rubber and plastic should be fitted to the faces of the clamps.

7. Design for Safety:

Jigs and fixtures must be safe and convenient in use, following are the some

Factors for the safety of worker working on jigs and fixtures.

(A): Sharp corner on the body of jig and fixture should be avoided.

(B): Sighting surfaces should be cleared.

(C): Bolt and nut should be inside the body of jig or fixture and not protrude on the surface.

8. Sighting Surface:

Machining on the work piece must be clearly visible to the worker. He should not be required to bend his neck for seeing the work piece or work surfaces.

9. Simplicity in design:

Design of the jig and fixture should be a simple one. A completed design require a large maintenance. They should be easily to set , cheap in manufacture.

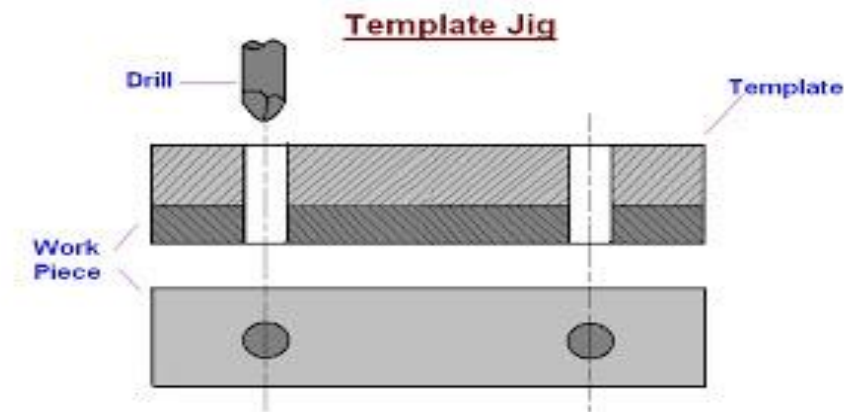
10. Economical:

Jig and fixtures should be simple in construction, give high accuracy , be sufficiently rigid and lightly weight. To satisfy these conditions an economical balance has to be made.

Types Of Drilling Jigs :-

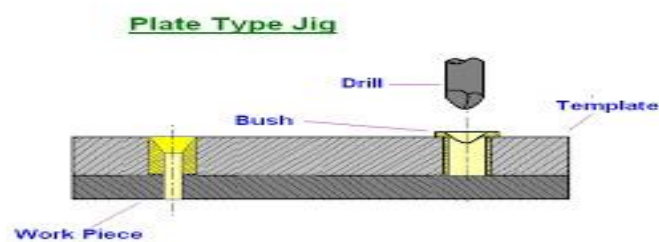
1. Template jig
2. Plate type jig
3. Open type jig
4. Channel jig
5. Leaf Jig
6. Box type jig

1. Template Jig:-



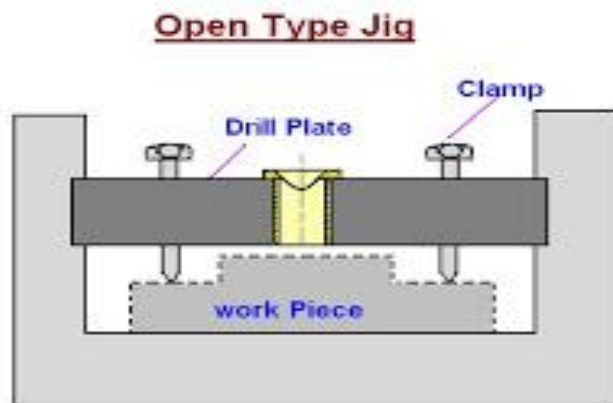
- This is the simplest type of jig;
- It is simply a plate made to the shape and size of the work piece with the require number of holes made it.
- This type of jig is suitable if only a few part are to be made.

2. Plate Type Jig :-



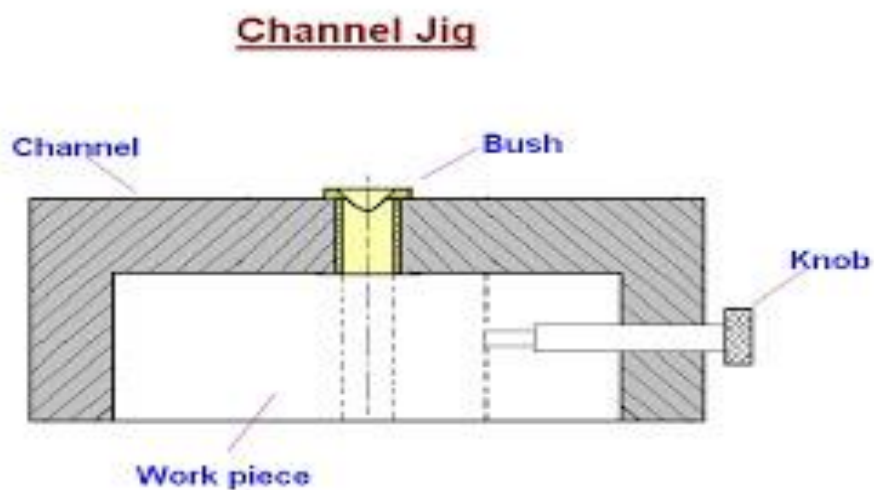
- This is an improvement of the template type of jig.
- In place of simple holes, drill bushes are provided in the plate to guide the drill.
- The work piece can be clamped to the plate and holes can be drilled.
- The plate jig are employed to drill holes in large parts, maintaining accurate spacing with each other.

3. Open Type Jig:-



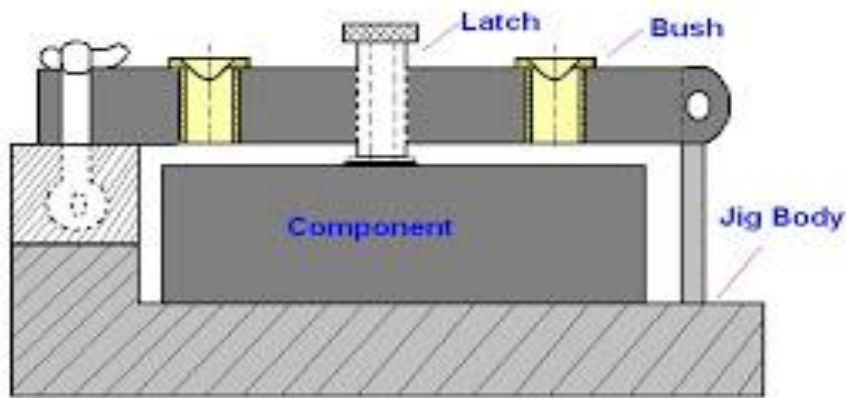
- In this jig the top of the jig is open.
- Work piece is placed on the top.

4. Channel jig :-



- The channel jig is a simple type of jig having channel like cross section.
- The component is fitted within the channel is located and clamped by locating the knob.
- The tool is guided through the drill bush.

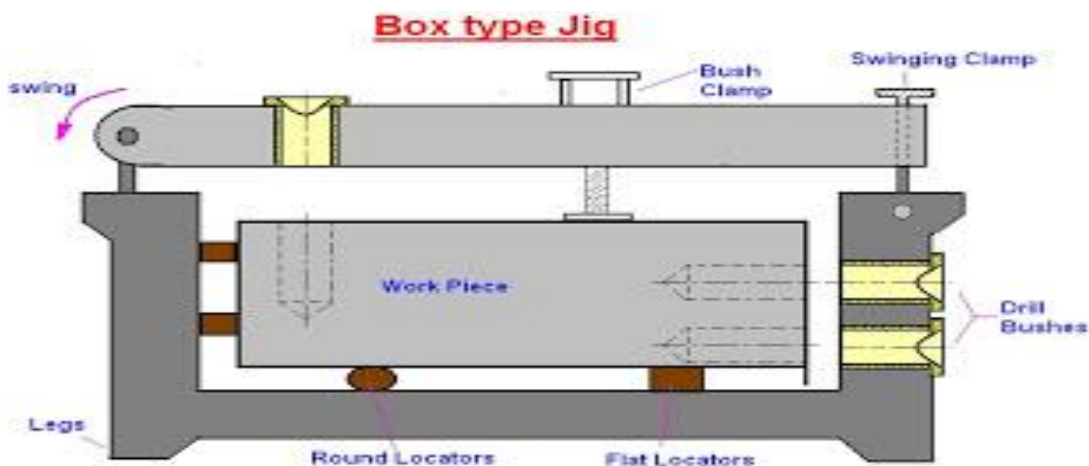
5. Leaf Jig :-



Leaf Jig

- It is also a sort of open type jig in which the top plate is arranged to swing about a fulcrum point so that it is completely clear of the jig for easy loading and unloading of the work piece.
- The drill bushes are fitted into the plates which are also known as leaf, latch or lid.

6. Box Type Jig :-



- When the holes are to drill more than one plane of the work piece, the jig has to be provided with equivalent number of bush plates.
- For positioning jig on the machine table feet have to be provided opposite each drilling bush plate.
- One side of the jig will be provided with a swinging leaf for loading and unloading the work piece, such a jig would take the form of a box.
- This type of jig should be as light as possible Since it will have lifted again and again.

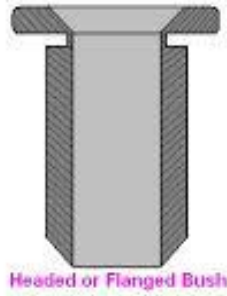
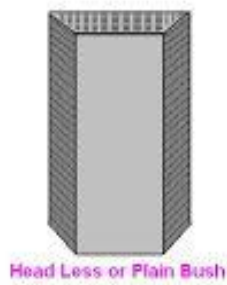
DRILL BUSHES:-

- These are used to guide drills, reamers and other cutting tools to the workpiece.
- Bushes are made of water hardening carbon steel with 0.85 to 1% carbon and 0.50 to 0.9% of manganese and hardened to RC60 to 64 to minimize wear due to contact with hard rotating tools. Jig bushings are used in drilling and boring jigs.
- Their use permits giving up the reduction of drill run off and hole expansion.
- The diametric accuracy of holes in drilling is 50% higher on the average compared to that of holes drilled conventionally.

TYPES OF DRILL BUSHES:-

1. Press fit bushes -
 - a) Headless or plain bush
 - b) Headed or flanged bush
 - c) Headed or collared press fir bush
2. Renewable bushes
 - a) Fixed bushes
 - b) Slip bushes
3. Linear bushes
4. Threaded bushes
5. Screw or clamping bush

Press Fit Wearing Bush



DIFFERENCE BETWEEN JIGS AND FIXTURES :-

<u>JIGS</u>	<u>FIXTURES</u>
1.It is a work holding device that holds, supports and locates the work piece and guides the cutting tool for a specific operation.	1. It is a work holding device that holds, supports and locates the work piece for a specific operation but does not guide the cutting tool.
2. Jigs are not clamped to the drill press table unless large diameters to be drilled and there is a necessity to move the jig to bring one each bush directly under the drill.	2. Fixtures should be securely clamped to the table of the machine upon which the work is done.
3. The jigs are special tools particularly in drilling, reaming, tapping and boring operation.	3. Fixtures are specific tools used particularly in milling machine, shapers and slotting machine.
4. Gauge blocks are not necessary.	4. Gauge blocks may be provided for effective handling.
5. Lighter in construction.	5. Heavier in construction.

Unit 2 GAUGES



INTRODUCTION:

There are several methods available for the control of dimensions of components in a system of limits and fits.

- Each component be measured with an instrument for closely limited work with suitable accuracy.
- The method used for majority of work, in quantity production is the system of limit gauges.
- This has the advantage that it can be operated on many gauges unskilled persons.
- Gauges are inspection tools of rigid design without a scale which serve to check the dimensions of manufactured parts.
- Gauges do not indicate actual value of inspected dimensions of the components. They are only used for determining specified limits.
- Workmen checking a component with a gauge do not have to make any calculation.
- Gauges are easy to employ.

DIFFERENCES OF GAUGES AND MEASURING INSTRUMENTS FOR GAUGES:-

1. No adjustment is necessary in their use.
2. They usually are not general purpose instruments, but are specially made for some particular parts, which is to be produced in sufficiently large quantity.

CLASSIFICATION OF PLAIN GAUGES

A. ACCORDING TO TYPE

1. STANDARD GAUGES:-

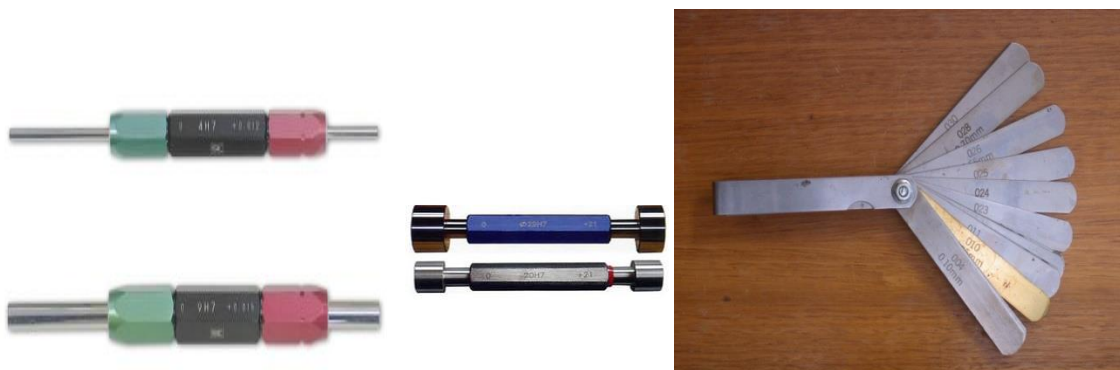
If a gauge is made as an exact copy of mating part in so far as the dimensions to be checked are concerned called a standard gauge.

2. LIMIT GAUGES:-

The system of limit gauges is very widely used in industries. These are used to limit the dimensions of part of tested. Since the dimensions of a properly manufactured part must be within the prescribed limit. One of the gauges part called as GO gauges and NO GO gauge.

GO: Gauge should pass through/over the part.

NOGO: Should not pass through over the part.



B. ACCORDING TO PURPOSE

1) WORKSHOP GAUGE:-

- Used by machine operator to check dimensions of part as they are being produced.
- They are designed so as to keep the size of the part near the centre of the limit tolerance.

2) INSPECTION GAUGE

- Used by inspector in the final inspection of acceptance of manufactured parts when finished.
- Those gauge are made to slightly larger tolerance than the workshop gauges so as to accept the work slightly nearer the tolerance limit than the workshop gauges.

3) REFERENCE /MASTER GAUGES

These gauges are used only for checking the size and conditions of other gauges.

- Master gauges are reverse /opposite in the form of working/inspection gauges.
- Due to expenditure involved, reference and master gauges are seldom used and gauges are checked by universal measuring instruments (optimeter, comparator or snap gauges).

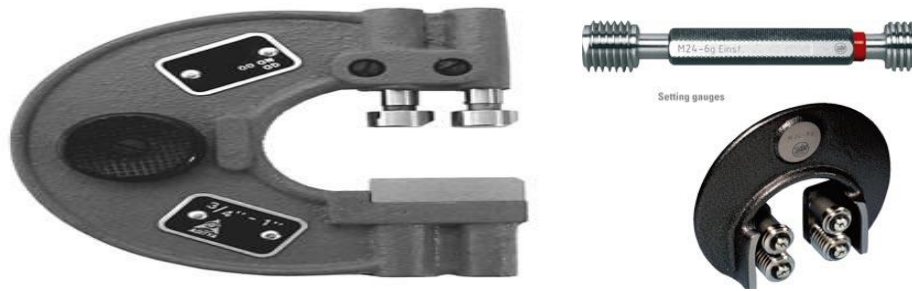


C. ACCORDING TO FORM OF TESTED SURFACE:-

1. PLUG GAUGE

- GO PLUG GAUGE: Size of low limit of the hole.
- NO GO PLUG GAUGE: High limit of the hole.

2. SNAP GAUGE, GAP/RING GAUGE:-



Used for gauging the shaft/male components.

- GO SNAP GAUGE: Size of high limit
- NOT GO SNAP GAUGE: Size of low limit

DESIGN OF LIMIT GAUGES

The following factors must be kept in mind while designing the limit gauges:-

1. Limit gauge tolerance
 - a) Manufacturing tolerance
 - b) Wear tolerance:- not provided when work tolerances are less than 0.09mm.

These tolerances are related with respect to the work tolerance.

2. Taylor's principle of gauge design
3. Fixing of gauging element with handle
4. Provision of pilot
5. Correct centering
6. Material
7. Hardness and surface finishing
8. Rigidity
9. Alignment

AMOUNT OF MANUFACTURING TOLERANCES:-

There is no universally accepted policy for the amount of gauge tolerance. However following norms are generally accepted:-

- The tolerances on each gauge whether GO/NOT GO is $1/10^{\text{th}}$ of work tolerance.

- The amount of tolerance on inspection gauges is generally 5% of the work tolerance and master gauge is generally 10% of gauge tolerance.

Question: 1

Find the GO and NOT GO gauge dimensions of plug gauge using bi and unilateral system and including wear allowance for gauging 75 ± 0.05 mm diameter hole?

Answer: Unilateral system

$$\text{high limit} = 75.05\text{mm}$$

$$\text{low limit} = 74.95\text{mm}$$

$$\text{Work tolerance} = 0.1\text{mm}$$

$$\text{Gauge maker's tolerance is } 10\% \text{ of work tolerance} = 0.01\text{mm}$$

$$\text{Wear tolerance is } 5\% \text{ of work tolerance}$$

$$= 0.005\text{mm}$$

$$\text{GO side plug gauge after app. Of wear tolerance} = 74.95 + 0.005$$

$$= 74.955$$

Dimensions of gauge

Unilateral:

$$\text{GO: } 74.955 + 0.01, 74.955 - 0.00$$

$$\text{NOT GO: } 75.05 + 0.00, 75.05 - 0.01$$

Bilateral:

$$\text{GO: } 74.955 + 0.005, 74.955 - 0.005$$

$$\text{NOT GO: } 75.05 + 0.005, 75.05 - 0.005$$

QUESTION 2:

If the work tolerances are 10 units then find out Manufacturing Tolerance of GO and NOT GO gauge?

ANSWER:-

The amount of tolerance of an inspection gauge is generally 5% of work tolerance and master gauge is generally 10% of gauge tolerance.

Let the size of shaft to be tested be 25 ± 0.02 mm.

Unilateral system:

High Limit = 25.02

Low Limit = 24.98

Work tolerance = 0.04 mm

Gauge makers Tolerance @ 10% of work tolerance = 0.004 mm (4 micron)

Dimension of go gauge = $24.98 + 0.004$, $24.98 - 0.000$

Not go gauge = $25.02 + 0.000$, $25.02 - 0.004$

Wear Tolerance:-

Wear Tolerance = 5% of work tolerance

$$= 0.004 * 5\%$$

$$= 0.002 \text{ mm}$$

$$\Rightarrow 24.98 + 0.002 = 24.982$$

Wear Tolerance of GO Gauge = $24.982 + 0.004$, $24.982 - 0.000$

Unit 3 MACHINE TOOL MAINTENANCE

❖ TYPES OF MAINTENANCE:

1. Preventive maintenance
2. Corrective / breakdown maintenance
3. Scheduled / Routine maintenance
4. Predictive maintenance
5. Non-routine maintenance
6. Accident maintenance
7. Special maintenance
8. Condition based maintenance
 - a) Primary signal
 - b) Secondary signal

Duties and Functions of Plant Maintenance :

Depending on the size of maintenance department the work is under the control of maintenance engineering which normally reports to work engineering.

The different duties are as follows:-

(A) INSPECTION

- Schedule check, Routing
- Ensure safe & efficient operations
- Frequency of operation depends on the use of the equipments

During maintenance & overhauling determine the feasibility of repair, incoming material for their fitness.

(B) ENGINEERING

- It involves alteration & improvements to minimize breakdown
- Undertakes constructional projects that will become part of the plant
- Engineering & consulting services to production supervisors.

- (C) MAINTENANCE: (Including preventive maintenance)
- (D) REPAIR
- (E) OVERHAUL
- (F) CONSTRUCTION
- (G) SALVAGE (i.e. Utilization of scrap)
- (H) CLERICAL JOBS
- (I) GENERATION & DISTRIBUTION OF POWER & OTHER UTILITY
- (J) ADMINISTRATION & SUPERVISION OF LABOUR FORCE
- (K) FIRE PROTECTION
- (L) ESTABLISHING & MAINTAINING SUITABLE STORE
- (M) JANITORIAL SERVICES
- (N) HOUSEKEEPING
- (O) POLLUTION & NOISE CONTROL

□ PREVENTIVE MAINTENANCE SYSTEM:

□ PREVENTIVE MAINTENANCE SYSTEM:

(G) (I) (R) (I) (R) (I) (M) (I) (R) (I) (R) (I) (M) (I) (R) (I) (R) (I) (G)

G – GENERAL OVERHAULLING	-	2
I – INSPECTION	-	9
R – ROUTINE REPAIR	-	6
M – MEDIUM REPAIR	-	2

Type of Maintenance

1. **Breakdown maintenance:** It means that people waits until equipment fails and repair it. Such a thing could be used when the equipment failure does not significantly affect the operation or production or generate and significant loss other than repair cost.

2. Preventive maintenance (1951) : It is a daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the prevention of deterioration, periodic inspection or equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2a. Periodic maintenance (Time based maintenance – TBM): Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.

2b. Predictive maintenance: This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

3. Corrective maintenance (1957): It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability.

4. Maintenance prevention (1960): It indicates the design of a new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

❑ **Advantages of Preventive Maintenance System :**

- 1) Reduced breakdown
- 2) Reduced overtime & lesser odd time-repair
- 3) Greater safety for workers
- 4) Fewer large scale & repetitive repairs
- 5) Low maintenance & repair costs
- 6) Low consumable of spare parts
- 7) Increased life better product quality at low cost
- 8) Better industrial relations because workers don't face lay-off & loss of incentive bonus
- 9) Identification of equipments requiring high maintenance cost

Unit 4 PLANT LAYOUT

The efficiency of production depends upon how well the various machines and production facilities and employee amenities are located in a plant.

Only the properly laid out plant can ensure the smooth and rapid movement of material from the raw material stage to the end product stage.

Plant layout encompasses new layout as well as improvement in existing layout. Plant Layout consists following processes:-

- Arrangement of physical facilities in factory.
- Quickest flow of material
- Least price
- Least amount of handling in processing

IMPORTANCE OF PLANT LAYOUT:-

- Optimum relationship among output, floor area & manufacturing process.
- Minimize material handling time & cost.
- Flexibility of operations & easy production flow.
- Economic and effective utilization of manpower and machinery.
- Provide safe, comfortable and natural environment to employee.
- Effects flow of material, processes, labour efficiency, and supervision, use of space & expansion possibilities.

OBJECTIVES OF GOOD PLANT LAYOUT:-

- Effective utilization of available floor space
- To ensure work proceed from one point to another without delay
- Provide enough production capacity
- Reduce material handling cost
- Reduce hazards to personnel
- Effective utilization of manpower
- Increase employee moral
- Reduce accidents

- Flexibility in production and volume
- Provide ease of supervision and control
- Provide for employee supervision and control
- Allow ease of maintenance
- Improve productivity

PRINCIPLE OF PLANT LAYOUT

- Integration
- Minimum movements & material handling.
- Smooth & continuous flow.
- Cubic space utilization.
- Safety & improved environments.
- Flexibility.

TYPES OF PLANT LAYOUT

1.Product /Line Layout /Mass Production:-

- M/C's & equipments are arranged in one line depending upon the sequence of operations required for the product.
- Material move from one station to another sequentially without any backtracking / deviation.
- Under this M/C's are grouped in one sequence.
- Materials are fed into one the first M/C & finished goods travel automatically from M/C to M/C. The O/P of one M/C becoming the I/P of other.

ADVANTAGES:-

- Low cost of material handling due to straight & short route.
- Absence of backtracking
- Smooth and uninterrupted operations
- Continuous flow of work.
- Lesser investment in inventory and work in production.
- Shorter processing time and quicker output.
- Less congestion of work in process.
- Lower cost of manufacturing/unit.
- Simple and effective inspection of works and simplified production control.

DISADVANTAGES:-

- High initial capital investment in SPM.
- Heavy overhead charges.
- Breakdown of one machine will hamper the whole of production processes.
- Lesser flexibility

SUITABILITY:-

- Mass production of standardized products.
- Simple and repetitive manufacturing process.
- Reasonably stable demand.

2.Process / Functional Layout:-

- Machines of similar type arranged at one place.
ex .:- drilling department, milling department etc.
- Machines chosen to as many different jobs as possible i.e. Emphasis is on GPM.
- Work allocated according to loading schedules, ensuring each machine is fully loaded.

ADVANTAGES:-

- Lower initial capital investment in machines& equipments.
- High degree of machine utilisation.
- Relatively low overhead costs.
- Change in O/P design and volume can be more easily adapted to O/P of verity of products.
- Breakdown of one machine does not result in complete work stoppage.
- More effective and specialized supervision.
- Greater flexibility and scope for expansion.

DISADVANTAGES:-

- High material handling cost due to back track.
- High cost due requirement of high skilled labour.

- Time gap/ laq in production is higher.
- Work in process inventory is high needing greater storage space.
- Costly supervision due to frequent inspections.

SUITABILITY :-

- | | |
|--------------------|-----------------------------|
| 1.Non standardized | 3.frequent change in design |
| 2. Small quantity | 4.machines are expensive. |

3. FIXED POSITION/ LOCATION LAYOUT:-

- Major product being produced is fixed at one location.
- Equipments, labour and components are moved to that location.
- All facilities arranged around work center.
- Not relevant for small scale entrepreneurs.

ADVANTAGES:-

- Saves time and cost involved on the movement of work from the one workstation to other.
- Flexible layout as change in job design & operation sequence can be easily incorporated.
- It is more economical when several orders in different stages of progress are being executed simultaneously.
- Adjustments can be made to meet shortage of materials or absence of workers by changing the sequence of operations.

DISADVANTAGES:-

- Heavy capital investment due to long production period
- Large space requirement for storage of material and equipment near product
- Possibility of confusion and conflicts among different groups as several operations often carried out simultaneously.

SUITABILITY:-

- Manufacture of bulky and heavy products such as locomotives, ships, boilers, aircrafts, wagon etc.
- Construction of buildings, dams etc.
- Hospital, medicines, doctors and nurses are taken to the patient.

COMBINED LAYOUT:-

- Generally combinations of all three processes namely intermittent, continuous and representative process.
- Several products produced in repeated numbers with no likelihood of continuous production

FACTORS INFLUENCING LAYOUT:-

1. Factory Building:-

Nature and size of building determines the floor space available for layout

a) Nature of Product

- Product layout is suitable for uniform products whereas process layout is more appropriate for custom made products.

b) Production Process

- In assembly line product layout is better while in job order/intermittent manufacturing process layout is desirable.

c) Type Of Machinery

- GPM's are often arranged as per process layout while SPM's as product layout.

2. Repair and Maintenance:-

Machine arranged in a way that adequate space is available between them for movement of equipment and people for repairing machines.

a) Human Needs

- Adequate arrangement for amenities such as toilet, drinking water, wash room etc.
- Proper arrangement for effluent disposal.

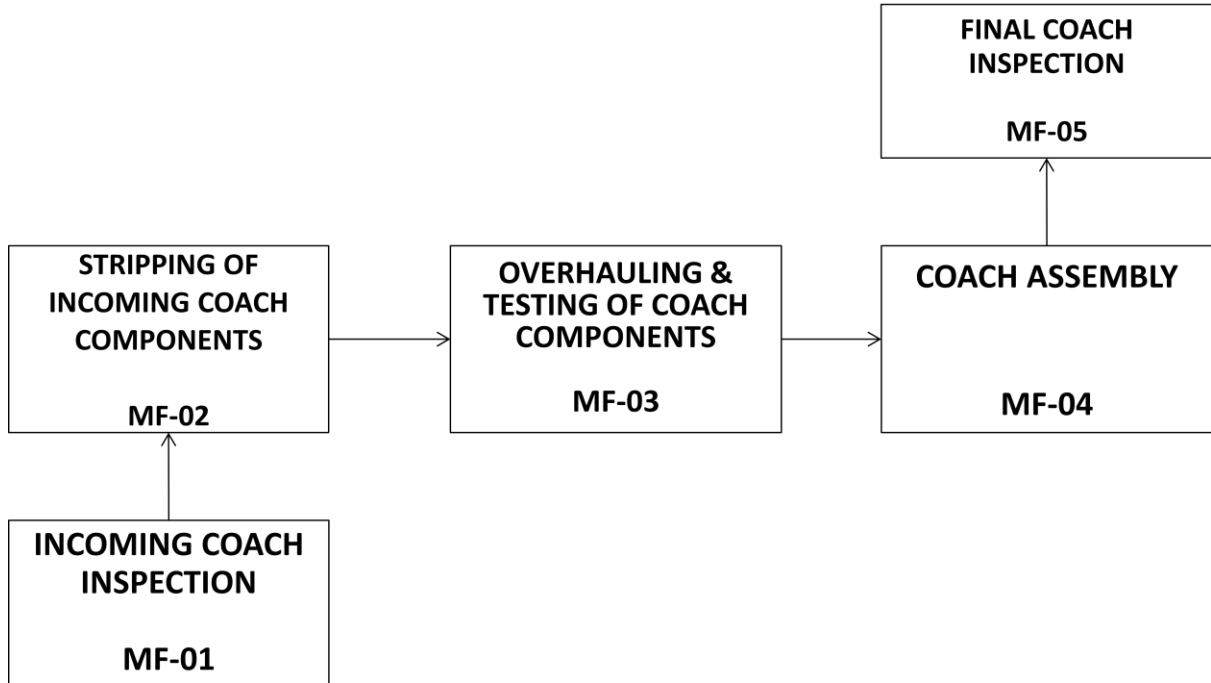
b) Planet Environment

- Proper consideration to heat, light, noise, ventilation and adequate safety arrangement.

c) Future Expansion And Diversification

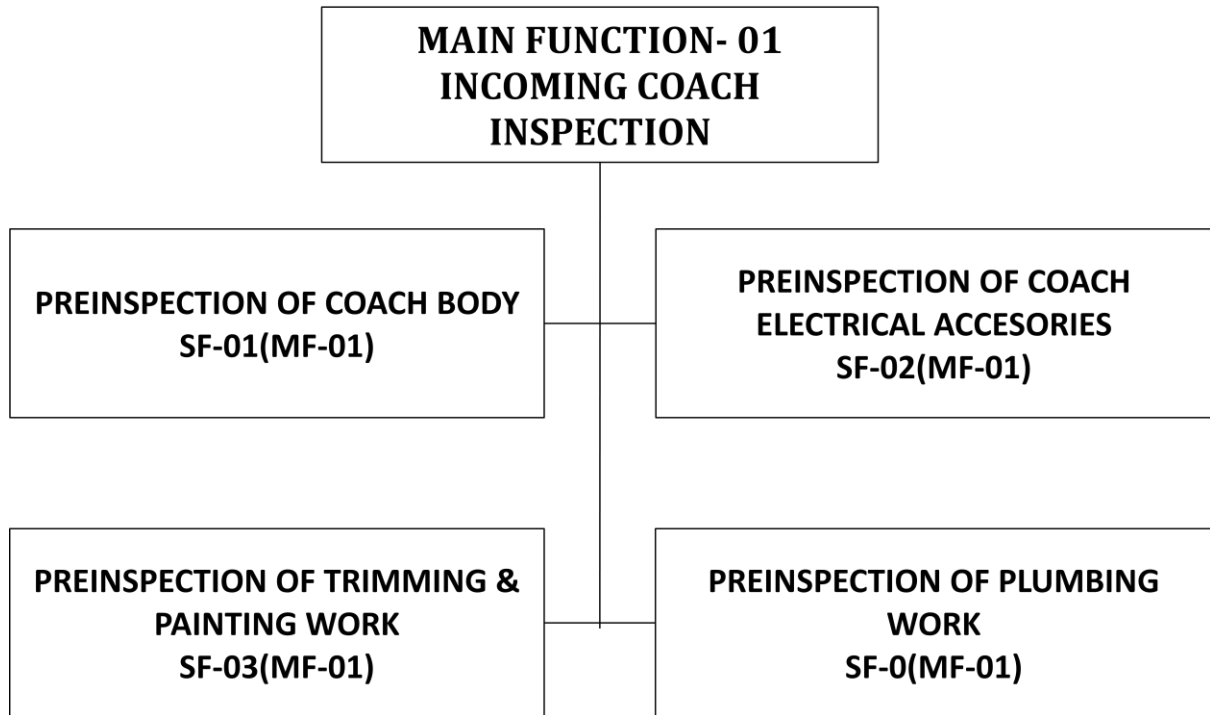
Unit 5 Process Flow Diagram

COACH OVERHAULING PROCESS:-

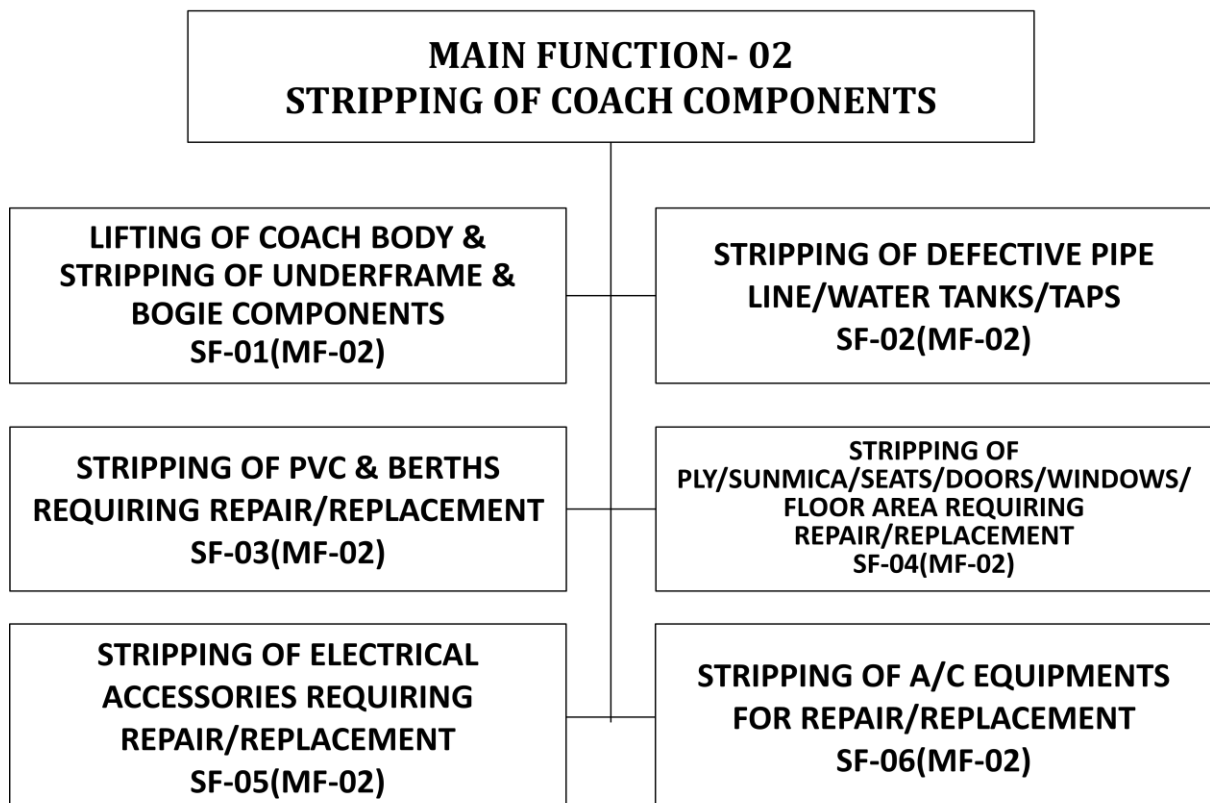


PROCESS FLOW DIAGRAM OF COACH OVERHAULING

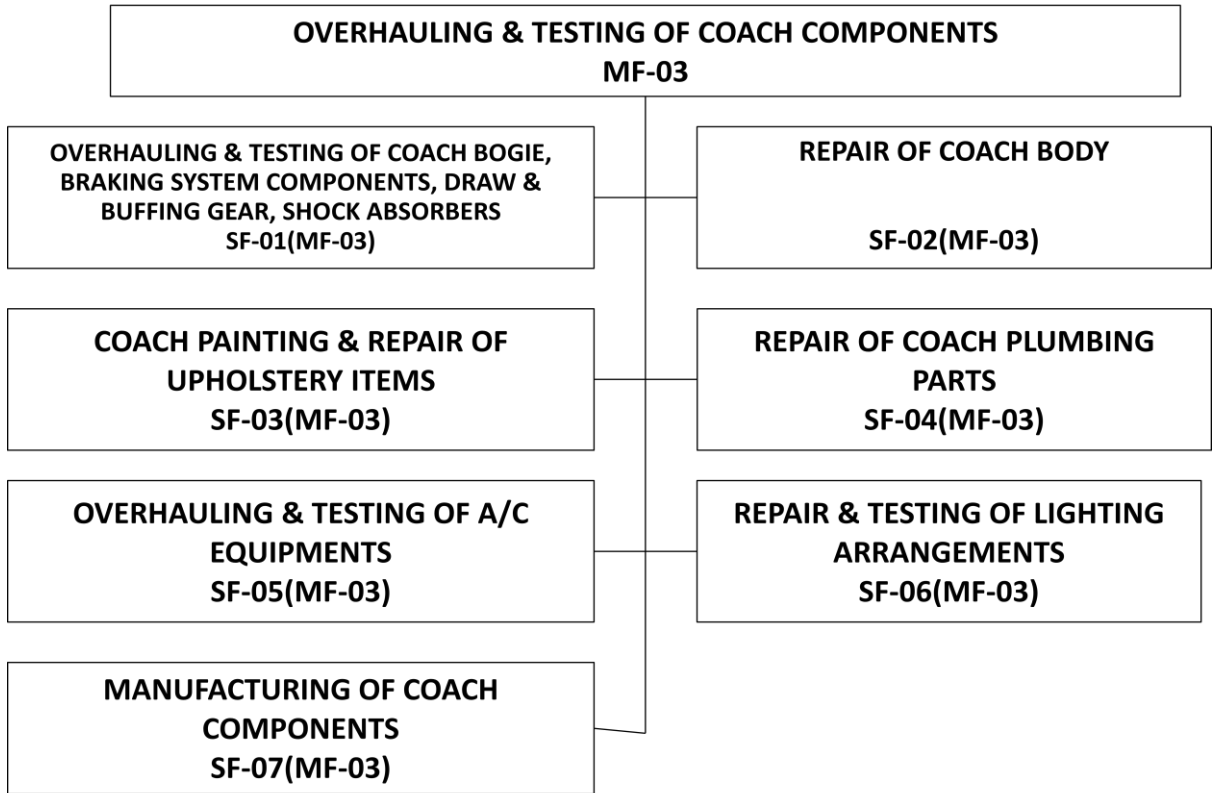
COACH OVERHAULING PROCESS:-



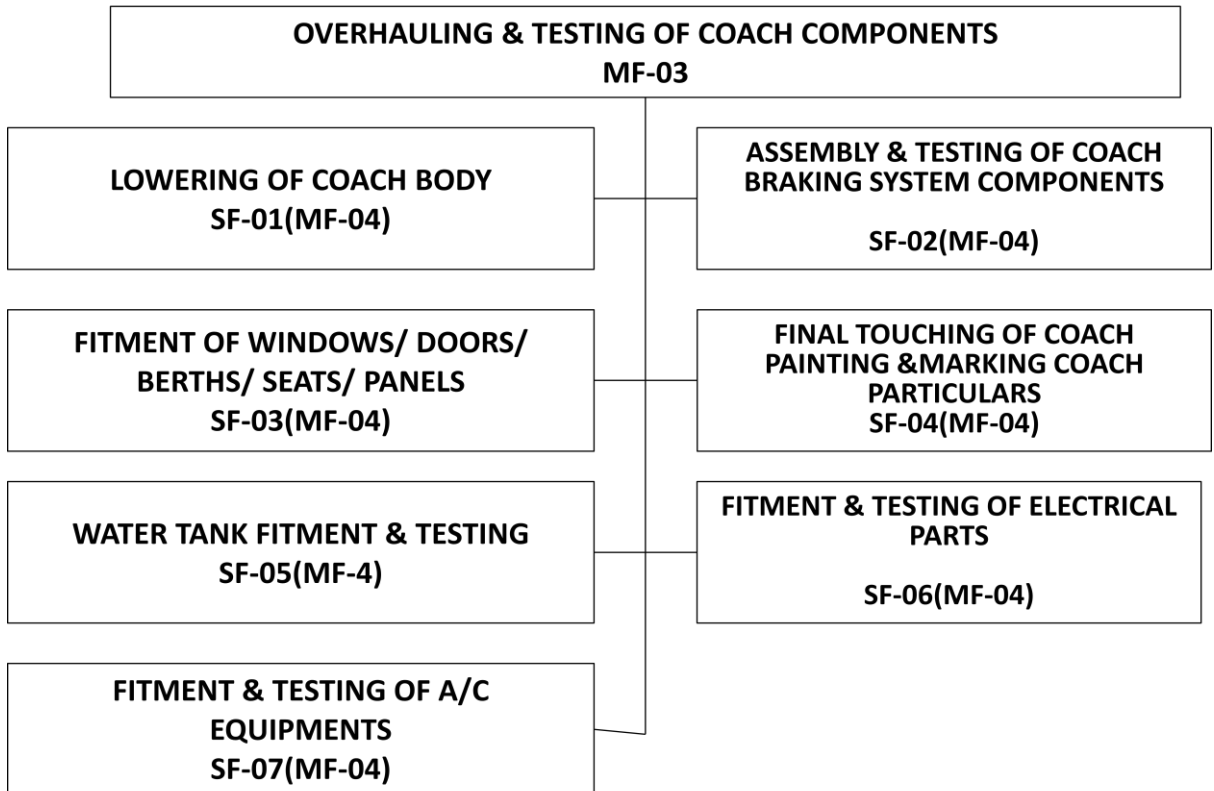
COACH OVERHAULING PROCESS



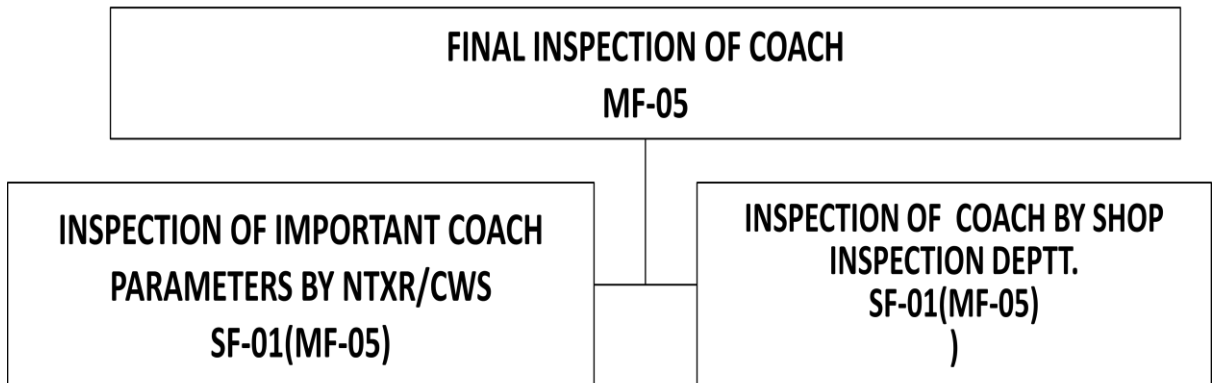
COACH OVERHAULING PROCESS



COACH OVERHAULING PROCESS



COACH OVERHAULING PROCESS



Unit 6 PRODUCTION PLANNING & CONTROL

A production planning & control has many functions to perform same before the arrival of raw material, tools & others, While the raw material undergoes processing .

CLASSIFICATION OF PPC:-

PLANNING PHASE

PRIOR PLANNING

- 1) FORE CASTING
- 2) ORDER WRITING
- 3) PRODUCT DESIGN

ACTIVE PLANNING

- 1) PROCESS PLANNING & ROUTING
- 2) MATERIAL CONTROL
- 3) TOOL CONTROL
- 4) LOADING
- 5) SCHEDULING

ACTION PHASES :-

DISPATCHING

CONTROL PHASE :-

1. Progress Reporting :-

1.1 Data Processing

2. Corrective Action:-

2.1 Expediting

2.2 Replanning

PRIOR PLANNING:-

- **FORECASTING:** - Estimation of type, quantity & quality of future work.
- **ORDER WRITING:** - Giving authority to one or more person to undertake particular job.
- **PRODUCT DESIGN:** - Collection of information regarding specification, BOM, drawing etc.

ACTIVE PLANNING:-

➤ **PROCESS PLANNING & ROUTING :-**

Finding the most economical way of doing work & deciding how & where the work will be done.

➤ **MATERIAL CONTROL :**

It involves determine the requirements & control of material

➤ **TOOL CONTROL :-**

It involves determine the requirements & control of tools.

➤ **LOADING :-**

Assignment of work to man power, machinery etc.

➤ **SCHEDULING:-**

It is the time phase of loading & determine when & in what sequence the work will be carried out. It fixes the starting as well as finishing time of the job.

ACTION PHASE :-

Dispatching :- It is the transition from planning to action phase. In this phase the workers is ordered to start the actual job.

CONTROL PHASE:-

○ **PROGRESS REPORTING :-**

- Data regarding the job progress is selected.
- It is the interpreted by comparison with the present level of performance

○ **CORRECTIVE ACTION :-**

- **EXPEDITING:** - Expediting means taking action if the progress reporting indicates a deviation of the plan from the originally set targets.
- **REPLANNING:** - Replanning of the whole affairs becomes essential in case expediting fails to bring the deviated plan to its actual path.

TYPE OF PRODUCTION :-

1. CONTINUOUS PRODUCTION :-

- It involves a continuous / almost continuous physical flow of raw material.
- It makes use of special purpose machine produces standardized item in large quantity. Eg – chemical processing plant, cement & cigarette etc .
- It can be divided into two categories :-
 - a) Mass / Flow line Production.
 - b) Continuous / Process Production

2. INTERMITTENT PRODUCTION :-

- In intermittent production system is typified by the intermittent interrupted flow of material through the plant.
- It makes use of general purpose machines & produces components different in nature & small in quantities . Eg – m/c shops, repair & maintenance shops, welding shops / some intermittent production.
- It can be classified as :-
 - a) Batch production
 - b) Job production

CHARACTERISTICS OF MASS PRODUCTION :-

- There is scope for considerable division of labour.
- Machinery is laid as per the sequence of production.
- Material handling is reduce to minimum.
- Very little time is spend on the resting of machine.
- The flow of work is balanced.
- Work cycle are short & of repetitive nature.
- Time study can be applied to advantage to different operation.
- Work in progress is small as compared to intermittent production
- Procedure tools & material handling needs proper attention.

- It offers lowest production cost per unit.
- Flow production is preferred where there is continuous & regular product demand.
- Plant layout facilities & design to suit requirement.

CHARACTERISTICS OF CONTINUOUS / PROCESS PRODUCTION :-

- All products undergoes the same process. Raw material enter at one point & leaves as a finish product at another point.
- Material handling is automatic.
- Plant layout as per the requirement of production.
- Both types of workers i.e semiskilled / skilled are employed.
- Output & input are controlled.
- Machinery employed in one built to the needs.
- Good plants maintenance & effective quality control are the essential requirement.

CHARACTERISTICS OF BATCH PRODUCTION :-

- It is a very common type of production.
- Articles are manufactured in batches as per specific order procured.
- Drugs cloths, paints, parts, manufactured, forging machine & sheet metal press are example of batch production.
- Division of labour is possible.
- Flow of material is intermittent.
- Plant lay out is of the process type.
- Proper maintenance of equipment & machinery is essential.
- Process & product planning is done for each batch.
- Expediting & corrective action are very necessary.
- Good production control system must be developed.

CHARACTERISTICS OF JOB ORDER PRODUCTION:-

Flow of materials & parts from one location to another is intermittent.

- Mechanization & division of labour is not economical.
- Each job order is different from previous as regards its types specification, quality & quantity.
- Product design takes a lot of times.
- Prior planning becomes difficult.
- Schedule is prepared for each component of the product giving starting & finishing time.
- General purpose machinery & flexible layout are preferred.
- Skilled workers required & factory made special attachment or accessories do the needful.
- High degree of control is essential.
- Special purpose equipments required very small quantity to be manufactured.

PROCESS PLANNING:-

CONCEPT:-

- Process planning means preparation of work detailed plan.
- Process planning comes after it has been decided what is to be made.
- It develops the broad plan of manufacturer for the components.
- Process planning takes as it inputs the drawing which show what is to be made & forecast. Orders which indicates the product.
- Quantity to be manufactured.

STEPS INVOLVED IN PROCESS PLANNING :-

PROCESS PLANNING PROCEDURE :-

- **S** – **SELECT**
- **R** – **RECORD**
- **E** – **EXAMINE**
- **D** – **DEVELOP**
- **I** – **INSTALLED**
- **M** – **MAINTAIN**

INFORMATION REQUIRED TO DO PROCESS PLANNING :-

- Quantity of work to be done along with product specification.
- Quantity of work to be completed.
- Availability of equipment, tools & personnel's.
- Sequence of which operator will perform raw material.
- Names of equipment on which operator will be performed.
- Standard time for each operation.
- When the operation will be performed.

Scheduling & control of production:-

Scheduling concept

- Scheduling means when & in what sequence the work will be done
- It involves deciding as to when the work will start & in a certain duration of time how much work will be finished

Scheduling with orders & machines

It determines which order will be taken in which machine & which dept. by which operator.

Factors affecting scheduling:-

- External factors
- Internal factors

External factors

1. Customer demand
2. Customer delivery date
3. Stock of goods already lying with dealers

Internal factors :-

1. Time interval to process finished goods from raw material
2. Availability of equipment & machinery
3. Availability of raw material
4. Availability of man power
5. Additional manufacturing facilities if required
6. Feasibility of economic production running

Scheduling & control focus attention on following :-

1. Knowing the total overall production target how to determine the amount of each product to be manufacturing if there are product of different types & sizes.
2. How to decide a the deployed work force (Different types of workers & kind of skills) & equipment to achieve the target production rate .
3. How to determine individual work assignment.
4. What should be the information system to feedback quality & accurately ,the actual output duly compared with scheduling one.

SCHEDULING CONCEPT

Master schedule

Scheduling procedure & techniques scheduling normally starts with master scheduling

- A master schedule resembles control
- Office which possess information all the orders in hand

- As the orders are received depending upon
- Their delivery date ,they are marked as master schedule
- A master schedule does updated continually
- It show running of total of the production requirement & work yet to be completed

ADVANTAGE:-

1. It is simple & easy to understand
2. It can be kept running
3. It involves less cost to make it & maintain
4. It can be maintained by non technical staff
5. A certain % age of total weekly capacity can be allocated for such order

Disadvantage

1. It provides only overall picture
2. It does not give detailed information

Application

1. In big firms ,for the purpose of loading the entire plant
2. In research & development
3. For overall planning in found, computers

Control of production

Control phase & control production which of two parts

- A. Progress reporting
- B. Corrective action

Control system involve four stage

- A. Observation
- B. Analysis
- C. Corrective action
- D. Post operation evaluation

- E. The control of production is necessary to be sure that the production schedules are being made & the job will be delivered as per scheduled plan
- F. Production control involves information feedback mechanism & system of corrective action
- G. Production control follow up the schedule plan compare the actual output with the planned one & same point out the deviation. so that the same may be corrected, adjusted by man & machine.

In brief

- A. Receives work progress report
- B. Compare with scheduled plan
- C. Remove causes of delay in production
- D. Modified scheduled plan
- E. Expertise the work

Routing

Routing lays down the flow of work in the plant. It determines what work to be done & how it will be done. It determines the best and cheapest sequence of output and strictly follow procedure.

Routing procedure involves following different activities:

- Analysis of articles
- Determine the quality and Types of materials.
- Determination of Lot size.
- Determination of Scrap Factors.
- Analysis of cost organised production control forms.

Unit 7 INDUSTRIAL SAFETY

In modern construction projects industries & production establishments, workers are exposed to various types of risks & hazards. These may be due to personal unsafe act of employee/defective plant & machinery.

- An accident caused due to these not only effect physically & mental health of workers but also create direct & indirect cost to organization.
- It also cause loss of productive manpower & material resulting in huge economic loss both for industrial & country.
- A statistics show that 75% accidents are caused due to human error (workers) & 25% due to unsafe equipment & methods (employers fault).
- Hence each workers should practice safe methods& use PPE's to avoid accidents during working.(personal protective equipments).

SAFETY & SAFETY CONSCIOUSNESS

- Safety in simple terms is the process of keeping oneself safe from accident.
- In order to minimize personal injuries' & property loss organization must layout accident program & well planned procedure.
- In order to create safety consciousness among workers, each personal should be given safety training, display of banners, promoting safety.

SAFETY PROCEDURES

- Following steps
- Analysis of conditions & causes of accident
- Design of equipment in relation to safety.
- Work methods in relation to safety.
- Training of accident prevention methods.
- Chemical approach to safety.

GENERAL SAFETY MEASURES

- Proper safety guards should be mounted on moving parts of m/c.
- Replace guards immediately after repairs.
- Do not try to clean oil lubricate/repair any m/c, while it is in motion.
- Do not try to stop m/c with your hand.
- Wear safety clothing.
- Maintain good shop etiquette & house keepings of shop floor.
- Clamp work piece & tools securely on any m/c.
- Heavy & complicated works core to be handled carefully with MHE.
- Get first aid immediately for any injury occur.
- Sufficient light should be provided on m/c.

INDIAN FACTORY ACT 1948 SAFETY

- (1) In every factory the following, namely-
 - (I) every moving part of a prime-mover and every flywheel connected to a prime-mover, whether the prime-mover or flywheel is in the engine house or not;
 - (ii) the headrace and tailrace of every water-wheel and water-turbine;
 - (iii) any part of a stock bar which projects beyond the head stock of a lathe; and
 - (iv) Unless they are in such position or of such construction as to be safe to every person employed in the factory as they would be if they were securely fenced, the following, namely:-
 - (a) Every part of an electric generator, a motor or rotary convertor;
 - (b) Every part of transmission machinery; and
 - (c) Every dangerous part of any other machinery; shall be securely fenced by safeguards of a substantial construction which shall be constantly maintained and kept in position while the parts of machinery they are fencing, are in motion or in use:
- (i) It is necessary to make an examination of any part of the machinery aforesaid while it is in motion or, as a result of such examination to carry out lubrication or other adjusting operation while the machinery is in motion, being an examination of operation which it is necessary to be carried out while that part of the machinery is in motion. Or

(ii) In the case of any part of a transmission machinery used in such process as may be prescribed (being a process of a continuous nature, the carrying on of which shall be or is likely to be substantially interfered with by the stoppage of that part of the machinery).

it is necessary to make an examination of such part of the machinery while it is in motion or, as a result of such examination, to carry out any mounting or shipping of belts or lubrication, or other adjusting operation while the machinery is in motion, and such examination or operation is made or carried out in accordance with the provisions of sub-section (1) of section 22.

(2) The State Government may by rules prescribe such further precautions as it may consider necessary in respect of any particular machinery or part thereof or exempt, subject to such condition as may be prescribed, for securing the safety of the workers, any particular machinery or part thereof from the Provisions of this section.

Section 22 Work On or Near Machinery in Motion

(1) Where in any factory it becomes necessary to examine any part of machinery referred to in section 21, while the machinery is in motion, or, as a result of such examination, to carry out-

(a) In a case referred to in clause (i) of the proviso to sub-section (1) of section 21, lubrication or other adjusting operation; or

(b) In a case referred to in clause (ii) of the proviso aforesaid, any mounting or shipping of belts or lubrication or other adjusting operation, while the machinery is in motion, such - examination or operation shall be made or carried out only by a specially trained adult male worker wearing tight fitting clothing (which shall be supplied by the occupier) whose name has been recorded in the register prescribed in this behalf and who has been furnished with a certificate of his appointment, and while he is so engaged,-

(a) Such worker shall not handle a belt at a moving pulley unless-

(i) The belt is not more than fifteen centimeters in width;

(ii) The pulley is normally for the purpose of drive and not merely a fly-wheel or balance wheel (in which case belt is not permissible);

(iii) The belt joint is either laced or fixed with the belt;

(iv) The belt, including the joint and the pulley rim, are in good repair;

(v) There is reasonable clearance between the pulley and any fixed plant or structure;

(vi) Secure foothold and, where necessary, secure handhold, are provided for the operator; and

(vii) Any ladder in use for carrying out any examination or operation aforesaid is securely fixed or lashed or is firmly held by a second person.

(b) Without prejudice to any other provision of this Act relating to the fencing of machinery, every set screw, bolt and key on any revolving shaft, spindle, wheel or pinions and all spur, worm and other toothed or friction gearing in motion with which such worker would otherwise be liable to come into contact, shall be securely fenced to prevent such contact.

(2) No woman or young person shall be allowed to clean, lubricate or adjust any part of a prime-mover or of any transmission machinery while prime mover or transmission machinery is in motion, or to clean, lubricate or adjust any part of any machine if the cleaning, lubrication or adjustment thereof would expose the woman or young person to risk of injury from any moving part either of that machine or of any adjacent machinery.

(3) The State Government may, by notification in the Official Gazette prohibit, in any specified factory or class or description of factories, the cleaning, lubricating or adjusting by any person of specified parts of machinery when those parts are in motion.

Section 23. Employment of Young Persons on Dangerous Machines

(1) No young person shall be required or allowed to work at any machine to which this section applies, unless he has been fully instructed as to the dangers arising in connection with the machine and the precautions to be observed, and-

(a) has received sufficient training in work at the machine, or (b) is under adequate supervision by a person who has a thorough knowledge and experience of the machine.

(2) Sub-section (1) shall apply to such machines as may be prescribed by the State Government, being machines which in its opinion are of such a dangerous character that young person's ought not to work at them unless the foregoing requirements are complied with.

Section 24. Striking Gear and Devices for Cutting off Power

(1) In every factory-

(a) Suitable striking gear or other efficient mechanical appliance shall be provided and maintained and used to move driving belts to and from fast and loose pulleys which form part of the transmission machinery, and such gear or appliances shall be so constructed, placed and maintained so as to prevent the belt from creeping back on to the first pulley;

(b) Driving belts when not in use shall not be allowed to rest or ride upon shafting in motion.

(2) In every factory suitable devices for cutting off power in emergencies from running machinery shall be provided and maintained in every workroom: Provided that in respect of factories in operation before the commencement of this Act,

the provisions of this sub-section shall apply only to workrooms in which electricity is used as power.

(3) When a device, which can inadvertently shift from "off" to "on" position, is provided in a factory- to cut off power, arrangements shall be provided for locking the device in safe position to prevent accidental starting of the transmission machinery or other machines to which the device is fitted.

Section 25. Self-Acting Machines

No traversing part of a self-acting machine in any factory and no material carried thereon shall, if the space over which it runs is a space over which any person is liable to pass, whether in the course of his employment or otherwise, be allowed to run on its outwards or inward traverse within a distance forty-five centimeters from any fixed structure which is not part of the machine: Provided that the Chief Inspector may permit the continued use of a machine installed before the commencement of this Act which does not comply with the requirements of this section on such conditions for ensuring safety as he may think fit to impose.

Section 26. Casing of New Machinery

(1) In all machinery driven by power and installed in any factory after the commencement of this Act,-

(a) every set screw, bolt or key on any revolving shaft, spindle, wheel or pinion shall be so sunk, encased or otherwise effectively guarded as to prevent danger;

(b) all spur, worm and other toothed or friction gearing which does not require frequent adjustment while in motion shall be completely encased, unless it is so situated as to be as safe as it would be if it were completely encased.

(2) Whoever sells or lets on hire or, agent of a seller or hirer, causes or procures to be sold or let on hire, for use in a factory any machinery driven by power which does not comply with the provisions of sub-section (1) or any rules made under sub-section (3), shall be punishable with imprisonment for

a term which may extend to three months or with fine which may extend to five hundred rupees or with both.

(3) The State Government may make rules specifying further safeguards to be provided in respect of any other dangerous part of any particular machine or class or description of machines.

Section 27. Prohibition of Employment of Women and Children Near Cotton-Openers

No woman or child shall be employed in any part of a factory for pressing cotton in which a cotton-opener is at work: Provided that if the feed-end of a cotton-opener is in a room separated from the delivery end by a partition extending to the roof or to such height as the

Inspector may in any particular case specify in writing, women and children may be employed on the side of the partition where the feed-end is situated.

Section 28. Hoist And Lifts

(1) In every factory-

(a) every hoist and lift shall be-

(I) of good mechanical construction, sound material and adequate strength;

(ii) properly maintained, and shall be thoroughly examined by a competent person at least once in every period of six months, and a register shall be kept containing the prescribed particulars of every such examination;

(b) every hoist way and lift way shall be sufficiently protected by an enclosure fitted with gates, and the hoist or lift and every such enclosure shall be so constructed as to prevent any person or thing from being trapped between any part of the hoist or lift and any fixed structure or moving part;

(c) The maximum safe working load shall be plainly marked on every hoist or lift, and no load greater than such load shall be carried thereon;

(d) The cage of every hoist or lift used for carrying persons shall be fitted with a gate on each side from which access is afforded to a landing;

(e) Every gate referred to in clause (b) or clause (d) shall be fitted with inter-locking or other efficient device to secure that the gate cannot be opened except when the cage is at the landing and that the cage cannot be moved unless the gate is closed.

(2) The following additional requirements shall apply to hoists and lifts used for carrying persons and installed or reconstructed in a factory after the commencement of this Act, namely:-

(a) where the cage is supported by rope or chain, there shall be at least two ropes or chains separately connected with the cage and balance weight, and each rope or chain with its attachments shall be capable of carrying the whole weight of the cage together with its maximum load;

(b) Efficient devices shall be provided and maintained capable of supporting the cage together with its maximum load in the event of breakage of the ropes, chains or attachments;

(c) An efficient automatic device shall be provided and maintained to prevent the cage from over-running.

(3) The Chief Inspector may permit the continued use of a hoist or lift installed in a factory before the commencement of this Act which does not fully comply with the provisions of sub-section (1) upon such conditions for ensuring safety as he may think fit to impose.

(4) The State Government may, if in respect of any class or description of hoist or lift, is of opinion that it would be unreasonable to enforce any requirements of sub-sections (1) and (2), by order direct that such requirement shall not apply to such class or description of hoist or lift.

Explanation :- For the purposes of this section, no lifting machine or appliance shall be deemed to be a hoist or lift unless it has a platform or cage, the direction or movement of which is restricted by a guide or guides.

Section 29. Lifting Machines, Chains, Ropes and Lifting Tackles

(1) In any factory the following provisions shall be complied with in respect of every lifting machine (other than a hoist and lift) and every chain, rope and lifting tackle for the purpose of raising or lowering persons, goods or materials:-

(a) All parts, including the working gear, whether fixed or movable, of every lifting machine and every chain, rope or lifting tackle shall be-

(i) Of good construction, sound material and adequate strength and free from defects;

(ii) Properly maintained; and

(iii) Thoroughly examined by a competent person at least once in every period of twelve months, or at such intervals as the Chief Inspector may specify in writing, and a register shall be kept containing the prescribed particulars of every such examination

(b) no lifting machine and no chain, rope or lifting tackle shall, except for the purpose of test, be loaded beyond the safe working load which shall be plainly marked there on together with an identification mark and duly entered in the prescribed register; and where this is not practicable, a table showing the safe working load of every kind and size of lifting machine or chain, rope or lifting tackle in use, shall be displayed in prominent position on the premises;

(c) while any person is employed or working on or near the wheel track of a travelling crane in any place where he would be liable to be struck by the crane, effective measures shall be taken to ensure that the crane does not approach within six metres of that place.

(2) The State Government may make rules in respect of any lifting machine or any chain, rope or lifting tackle used in factories-

(a) Prescribing further requirements to be complied with in addition to those set out in this section;

(b) Providing for exemption from compliance with all or any of the requirements of this section, where in its opinion, such compliance is unnecessary or impracticable.

(3) For the purposes of this section a lifting machine or a chain, rope or lifting tackle shall be deemed to have been thoroughly examined if a visual examination supplemented, if

necessary, by other means and by the dismantling of parts of the gear, has been carried out as carefully as the conditions permit in order to arrive at a reliable conclusion as to the safety of the parts examined.

Explanation.- In this section,-

(a) "Lifting machine" means a crane, crab, winch, teagle, pulley block, gin wheel, transporter or runway;

(b) "lifting tackle" means any chain sling, rope sling, hook, shackle, swivel, coupling, socket, clamp, tray or similar appliance, whether fixed or movable, used in connection with the raising or lowering of persons, or loads by use lifting machines.

Section 30. Revolving machinery

(1) In every factory in which the process of grinding is carried on there shall be permanently affixed to or placed ear each machine in use a notice indicating the maximum safe working peripheral speed of every grindstone or

abrasive wheel, the speed of the shaft or spindle upon which the wheel is mounted, and the diameter of the pulley upon such shaft or spindle necessary to secure such safe working peripheral speed.

(2) The speeds indicated in notices under sub-section (1) shall not be exceeded.

(3) Effective measure shall be taken in every factory to ensure that the safe working peripheral speed of every revolving vessel, cage, basket, flywheel pulley, disc or similar appliance driven by power is not exceeded.

Section 31. Pressure Plant

(1) If in any factory, any plant or machinery or any part thereof is operated at a pressure above atmospheric pressure, effective measures shall be taken to ensure that the safe working pressure of such plant or machinery or part is not exceeded.

(2) The State Government may make rules providing for the examination and testing of any plant or machinery such as is referred to in sub-section (1) and prescribing such other safety measures in relation thereto as may in its opinion, be necessary in any factory or class or description of factories.

(3) The State Government may, by rules, exempt, subject to such conditions as may be specified therein, any part of any plant or machinery referred to in sub-section (1) from the provisions of this section.

Section 32. Floors, stairs and means of access

In every factory

(a) All floors, steps, stairs, passages and gangways shall be of sound construction, and properly maintained and shall be kept free from obstructions and substances likely to cause persons to slip and where it is necessary to ensure safety, steps, stairs, passages and gangways shall be provided with substantial handrails;

(b) There shall, so far as is reasonably practicable, be provided, and maintained safe means of access to every place at which any person is at any time required to work;

(c) When any person has to work at a height from where he is likely to fall, provision shall be made, so far as is reasonably practicable, by fencing or otherwise, to ensure the safety of the person so working.

Section 33. Pits, Sumps, Openings in Floors

(1) In every factory every fixed vessel, sump, tank, pit or opening in the ground or in a floor which, by reason of its depth, situation, construction or contents, is or may be a source of danger, shall be either securely covered or securely fenced.

(2) The State Government may, by order in writing, exempt, subject to such conditions as may be prescribed, any factory or class or description of factories in respect of any vessel, sump, tank, pit or opening from compliance with the provisions of this section.

Section 34. Excessive weights

(1) No person shall be employed in any factory to lift, carry or move any load so heavy as to be likely to cause him an injury.

(2) The State Government may make rules prescribing the maximum weights which may be lifted, carried or moved by adult men, adult women, adolescents and children employed in factories or in any class or description of factories or in carrying on in any specified process.

Section 35. Protection of eyes

In respect of any such manufacturing process carried on in any factory as may be prescribed, being a process which involves-

(a) Risk of injury to the eyes from particles or fragments thrown off in the course of the process, or

(b) Risk to the eyes by reason of exposure to excessive light, the State Government may by rules require that effective screens or suitable goggles shall be provided for the protection of persons employed on, or in the immediate vicinity of, the process.

Section 36. Precautions Against Dangerous Fumes, Gases, etc

(1) No person shall be required or allowed to enter any chamber, tank, vat, pit, pipe, flue or other confined space in any factory in which any gas, fume, vapour or dust is likely to be present to such an extent as to involve risk to persons being overcome thereby, unless it is provided with a manhole of adequate size or other effective means of egress.

(2) No person shall be required or allowed to enter any confined space as is referred to in sub-section (1), until all practicable measures have been taken to remove any gas, fume, vapour or dust, which may be present so as to bring its level within the permissible limits and to prevent any ingress of such gas, fume, vapour or dust and unless-

(a) A certificate in writing has been given by a competent person, based on a test carried out by himself that the space is reasonably free from dangerous gas, fume, vapour or dust: or

(b) Such person is wearing suitable breathing apparatus and a belt securely attached to a rope the free end of which is held by a person outside the confined space.

Section 36A. Precautions regarding the use of portable electric light in any factory-

(a) no portable electric light or any other electric appliance of voltage exceeding twenty-four volts shall be permitted for use inside any chamber, tank, vat, pit, pipe, flue or other confined space unless adequate safety devices are provided; and

(b) if any inflammable gas, fume or dust is likely to be present in such chambers tank, vat, pipe, flue or other confined space, no lamp or light other than that of flame-proof construction shall be permitted to be used therein.

Section 37. Explosive or Inflammable Dust, Gas

Where in any factory any manufacturing process produces dust, gas, fume or vapour of such character and to such extent as to be likely to explode on ignition, all practicable measures shall be taken to prevent any such explosion by-

(a) effective enclosure of the plant or machinery used in the process;

(b) removal or prevention of the accumulation of such dust, gas, fume or vapour;

(c) exclusion or effective enclosure of all possible sources of ignition.

(2) Where in any factory the plant or machinery used in a process such as is referred to in sub-section (1), is not so constructed as to withstand the probable pressure which such an explosion as aforesaid would produce, all practicable measures shall be taken to restrict the spread and effects of the explosion by the provision in the plant or machinery of chokes, baffles, vents or other effective appliances.

(3) Where any part of the plant or machinery in a factory contains any explosive or inflammable gas or vapour under pressure greater than atmospheric pressure, that part shall not be opened except in accordance with the following provisions, namely:-

(a) before the fastening of any joint of any pipe connected with the part or the fastening of the cover of any opening into the part is loosened, any flow of the gas or vapour into the part of any such pipe shall be effectively stopped by a stop-valve or other means;

(b) before any such fastening as aforesaid is removed, all practicable measures shall be taken to reduce the pressure of the gas or vapour in the part or pipe to a atmospheric pressure;

(c) where any such fastening as aforesaid has been loosened or removed effective measures shall be taken to prevent any explosive or inflammable gas or vapour from entering the part or pipe until the fastening has been secured, or, as the case may be, securely replaced: Provided that the provisions of this sub-section shall not apply in the case of plant or machinery installed in the open air.

(4) No plant, tank or vessel which contains or has contained any explosive or inflammable substance shall be subjected, in any factory, to any welding, brazing, soldering or cutting operation which involves the application of heat unless adequate measures have first been taken to remove such substance and any fumes arising there from or to render such substance and fumes non explosive or non-inflammable and no such substance shall be allowed to enter such plant, tank or vessel after any such operation until the metal has cooled sufficiently to prevent any risk of igniting the substance.

(5) The State Government may by rules exempt, subject to such conditions as may be prescribed, any factory or class or description of factories from compliance with all or any of the provisions of this section.

Section 38. Precautions in case of fire

(1) In every factory, all practicable measures shall be taken to prevent outbreak of fire and its spread, both internally and externally, and to provide and maintain-

(a) Safe means of escape for all persons in the event of a fire, and

(b) The necessary equipment and facilities for extinguishing fire.

(2) Effective measures shall be taken to ensure that in every factory all the workers are familiar with the means of escape in case of fire and have been adequately trained in the routine to be following in such cases.

(3) The State Government may make rules, in respect of any factory or class or description of factories, requiring the measures to be adopted to give effect to the provisions of sub-sections (1) and (2).

(4) Notwithstanding anything contained in clause (a) of sub-section (1) or sub-section (2), if the Chief Inspector, having regard to the nature of the work carried on in any factory, the construction of such factory, special risk to life or safety, or any other circumstances, is of the opinion that the measures provided in the factory, whether as prescribed or not, for the purposes of clause (a) of sub-section (1) or sub-section (2), are inadequate, he may, by order in writing, require that such additional measures as he may consider reasonable and necessary, be provided in the factory before such date as is specified in the order.

Section 39. Power to require specifications of defective parts or tests of stability

If it appears to the Inspector that any building or part of a building or any part of the ways, machinery or plant in a factory is in such a condition that it may be dangerous to human life or safety, he may serve on the occupier or manager or both of the factory an order in writing requiring him before a specified date-

(a) to furnish such drawings, specifications and other particulars as may be necessary to determine whether such buildings, ways, machinery or plant can be used with safety, or

(b) to carry out such tests in such manner as may be specified in the order, and to inform the Inspector of the results thereof.

Section 40. Safety of buildings and machinery

(1) If it appears to the Inspector that any building or part of a building or any part of the ways, machinery or plant in a factory is in such a condition that it is dangerous to human life or safety, he may serve on the occupier or manager or both of the factory an order in writing specifying the measures, which in his opinion should be adopted and requiring them to be carried out before a specified date.

(2) If it appears to the Inspector that the use of any building or part of a building or any part of the ways, machinery or plant in a factory involves imminent danger to human life or safety he may serve on the occupier or manager or both of the factory an order in writing prohibiting its use until it has been properly repaired or altered.

Section 40A. Maintenance of buildings

If it appears to the Inspector that any building or part of a building in a factory is in such a state of disrepair as is likely to lead to conditions detrimental to the health and welfare of the workers, he may serve on the occupier or manager or both of the factory an order in writing specifying the measures which in his opinion should be taken and requiring the same to be carried out before such date as is specified in the order.

Section 40B. Safety Officers

(1) In every factory-

(i) Wherein one thousand or more workers are ordinarily employed, or

(ii) Wherein, in the opinion of the State Government, any manufacturing process or operation is carried on, which process or operation involves any risk of bodily injury, poisoning or disease or any other hazard to health, to the person employed in the factory, the occupier shall, if so required by the State Government by notification in

Official Gazette, employ such number of Safety Officers as may be specified in that notification.

(2) The duties, qualifications and conditions of service of Safety Officers shall be such as may be prescribed by the State Government.

Unit 8 MATERIAL HANDLING

There are two main functions and principles of Material Handling:-

1. To choose production machinery and assist in plant layout.
2. To choose most appropriate MHE which is safe and at the minimum possible overall cost.

DATA:

35 -40% Accidents due to bad methods of MHE

20 -60% MH cost – total production

A component may be handed even 50 times/more before it changes to final product.

PRINCIPLES:

- Minimise the movement in a production operation.
- Minimise the distance moved by adopting shortest route.
- Using the principle of containerization/palette to move optimum numbers of pieces same time.
- Using mechanical aids in place of manual labour.
- Safe handed, efficient, flexible and proper sized MHE should be selected.
- Utilize gravity for material movement whenever possible.
- Design container packages etc to reduce damage to the material in transit.

UTILISATION PRINCIPLE:

According to this principle, quantity size and weight of load handled is increased.

SIMPLIFICATION RULE:

Reduce/ Eliminate unnecessary movements/equipments.

RELIABILITY:

The equipment should be reliable as frequent fatigue may lead to partial/complete stoppage of work.

SELECTION OF MHE:

Following factors may be considered while selecting MHE:-

Materials to be moved:

Size of material, shape, weight, nature (solid, liquid , gas etc) should be considered.

Plant building and Layout:

Width of assets, uneven floor level, width of doors, height of ceiling, strength of floor walls column etc.

Types of production machines:

Different machines have different output for unit time.

The MHE should be able to handle the maximum output.

Types of material flow pattern:

Vertical flow pattern will require elevators, conveyors, pipes etc whereas horizontal flow pattern will needs trucks, overhead bridge cranes, conveyors etc.

TYPE OF PRODUCTION:

It affects the selection of MHE on large extent.

Conveyors are more suitable for mass production , power trucks for batch production.

Cost of MHE:

- Handling cost.
- Life of the equipment.
- Amount of care and maintenance required for MHE.

PRINCIPLE OF MHE

1. SYSTEMS PRINCIPLE : INTEGRATION
2. MATERIAL FLOW
3. MECHANIZATION
4. SIMPLIFICATION: REDUCE UNNECESSARY MOVEMENTS
5. GRAVITY
6. SPACE UTILIAZATION
7. SAFETY
8. EQUIPMENTS SELECTION : MOST ADEQUATE
9. FLAXIBILITY : WIDE VARIETY
10. PAY LOAD P :RATIO OF PAY LOAD / DEAD WEIGHT IS HIGH
11. UTILIAZATION : OPTIMUM
12. SIMPLE HANDLING
13. RELIABILITY
14. EASE OF MAINTENANCE

Unit 9 ENGINEERING DRAWING

Engineering graphics is the language for engineers and has applications in all branches of engineering. It is the universal graphic language used for effective communication among the engineers. Engineering drawing consists of various rules and regulations for the construction of a picture (2D, 3D) of an object.

It communicates ideas and information from one mind to another. It also communicates all needed information from the engineer who design a part to the workers which will make it.

Engineering drawing and artistic drawing both create pictures. But the purpose of artistic drawing is to convey emotion, artistic sensitivity in some way while the purpose of engineering drawing is to convey information.

Anyone can appreciate artistic drawing even if each viewer has own unique appreciation but engineering drawing requires some training to understand and has high degree of objective commodity in the interpretation.

Engineering drawings convey the following information:-

- **Geometry:**
The shape of the object , how the object will look when it is viewed from various angles such as - front, top, side etc.
- **Dimensions:**
The size of the object is capturing the accepted units .
- **Tolerances:**
The allowable variations for each dimension.
- **Material:**
It represents from what the item is made up.
- **Finish:**
It specifies the surface quality of the item, functional/ cosmetic.

A variety of line styles graphically represents physical objects. Some lines are as follows:

Visible:

Continuous lines used to depict edge directly visible from a particular angle.

Hidden:

Short dashed lines used to represent the edges that are not directly visible.

Center:

Centre are alternatively long and short dashed line that may be used to represent the axes of circular features.

Cutting Plane:

Thin medium dashed lines as thick alternatively long and double short dashed that may be used to define sections for section works.

Types of Projection methods:**First angle projection method:**

Object is between the viewer and plane of projection. Here the top view is under the front view. The right view is at the left of front view.

Third angle projection method:

Plane of projection is between the viewer and the object. The left view is placed on the left and the top view on the front view is below top view.

Scale:

Plans are usually scale drawings means that the plans are drawn at specific ratio relative to the actual size of the place/object.

Dimensioning methods:

Distances may be indicated with either of two standardized forms of dimensions.

Linear Dimensions:

Two parallel lines called extension lines spaced at the distance between two features are shown at each of the features. A line perpendicular to extension lines called the dimension lines with arrows at its end point is shown between and terminating at the extension lines. The distance is indicated numerically at the mid point of dimension line either adjacent to it or in a gap provided for it.

Co-ordinate dimensions:

One horizontal and one vertical extension line establish an origin for the entire view. The origin is identified with zeros placed at the ends of these extension lines. Distances along the X and Y axis to other features are specified using other extension lines with the distances indicated numerically at their ends.

Sizes of circular features are indicated using either dimetral/ radial dimensions. Radial dimensions use on R followed by the value for the radius.

Dimetral dimension use a circle with forward leaning diagonal line through it called the diameter symbol followed by the value for the diameter.

Unit 10 WORK ORDER NUMBERING SYSTEM

Computerized System of Numbering of Work Orders:-

Under computerization a work order code in 7 digits with eighth check digit should be followed in Railway workshops. The system has been discussed in the paragraphs that follows. The numbering system provides enough room for classifying and booking conditions against new headings that may be required in future. The work order No. should be legibly and correctly written on all the documents in order to avoid rejection by the computer.

The format for eight-digit work order numbering is discussed below:

(a) The first two digits will represent control work order No. Separate place numbers being assigned for Loco workshops, Carriage and Wagon Workshops and those common in both the workshops.

(b) The next two digits i.e. 3rd and 4th digits will represent any of the following activities:-

(i) Engine part and nature of repairs etc.

(ii) Types of coaches and nature of repair, etc.

(iii) Codes of Divisions, Departments in case of non-divisionalised departments, workshops.

(iv) Codes for shop members within the workshops.

(v) Codes for type of metal applicable to control work orders for Foundry Shops and saw Mill operations.

(vi) In case of manufacture work orders year and Half year viz. 0 for 1970, 1 for 1971 etc. The 4th digit will represent half year viz. 1st Half year will be indicated by 1 and 3 for Costing series and 2 and 4 for non-costing series Second half year will be indicated by 5 and 7 for costing series and 6 and 8 for non-costing series.

(c) The next 3 digits i.e. 5th, 6th and 7th digits will represent

(i) Head of account: This will be in 3 digits representing last 3 digits of detailed Head of account both revenue as well as capital heads as per Revised Classification of accounts.

(ii) Serial No.: Serial No. to be allotted by the authority issuing work orders etc. Manufacturing Work Orders, Divisional Work Orders etc. should be limited between 001 to 999.

(iii) In case of on cost work orders for General on cost and shop on cost separate series of 3 digits code should be provided on the basis of nature of expenses.

(d) The last digit i.e. 8th digit will be a self checking digit which is designated to ensure the correctness of the first seven digits and the work order number will be complete with the digit. This list will have to be referred to every time when a work order is issued. A list of this digit shall be made available to all workshop offices, stores offices and workshop accounts offices for all possible first seven digits.

INDEX

Quality Management System

S. No	Description	Page No	
		From	To
1	Basic concept of Quality	171	173
2	Quality Control	174	180
3	Integrated Management System	181	195
4	Total Quality Management	196	200
5	Q.M.S. requirement, ISO 9001:2015	201	219

Unit 1- Basics Concept of quality

SOME IMPORTANT DEFINITION

Production: It is a method in which series of process are arrange in a systematic manner to convert raw materials into finish product.

Planning: It is a process in which a plan to execute the work in a systematic manners so that all the man machine material can be arranged at Right place during production so that maximum output can be achieved by minimum efforts.

Inspection: It is a process in which dimensions and level of products are matched with pre determine level.

Product Quality: Every manufacturing organization is concerned with the quality of its product while it is important that quality requirements should be satisfied.

Because customer satisfaction is derived from quality and quantity of products and series. Quality is a related term and generally used with reference to and use of product for example a gear use in sugarcane juice extracting machine may not process good surface finish , tolerance and accuracy as. With the gear use in the headstock of a still it may be considered of good quality if it work satisfactory in the juice extracting machine. It is essential that product must contain good quality as our customers purchase the product on its quality still it is very difficult to define product quality as a product may be of good quality for one customer but not for other.

It is easy for an engineer to define products quality according to the principle of engineer product quality may be define as a series of good properties by which it can be find out that how much our product has satisfied our customer.

The word quality has variety of meaning.

1. Fitness for purpose: The component is to possess good quality if it works well in the equipment for which it is went quality is these as fitness for purposes.
2. Grade: Quality is a distinguished feature grade product in appearance, performance, life, reliabilities taste odor maintainability etc. this is generally called as quality character.
3. Degree of preference: Quality is the degree to which a special product is preferred over competitive product of equivalent grade based on competitive cost by customer normally called product as customer preference.
4. Degree of excellence: Quality is a measure of degree of general excellence of the product.
5. Quality of products is measure fulfillment made to the customer.
6. It may be also define as a degree of confirmation to design and specifications.
7. The composite product characteristics of engineering and manufacturing that determine the degree to which the product in use also meet the expectations of the customers.

FACTOR AFFECTING THE QUALITY OF PRODUCT

Generally quality of any product depend upon following factors.

- A. Quality of design
- B. Conformance of design
- C. Performance of design

Quality of design: The quality of design of a product of concerned with the tightness of the specifications for manufacturer of the product for example a part which has a drawing tolerance of .001mm would be considered to have a better quality of design than another with a tolerance of 0.001mm.

Factor controlling quality of design:

1. Type of customer in market: For customer goods the important factor which governs the quality of design is the type of customer in the market. The study of optimum quality of design involves market survey .it is the study of:
 - a. Consuming habits of people.
 - b. The price they are willing to pay for various product and service.
 - c. The choice of design of the product which meet the needs of the customer.
2. Profit Consideration:From company point of view profit is more important. It is not necessary that the company should manufacturing 100% quality products.
3. Special requirements of the product: Generally greater the requirements for strength, fatigue, resistance, life, interchangeable of manufacturing of items closer should be the tolerance to give better quality goods.
4. High quality of design means higher cost quite often it also means higher value.

However, human ingenuity often finds way to make design both better and cheaper.

Conformance of design: The quality of conformance is concerned with how well the manufacturer product confirm to the quality of design.

When a design has been established it is the task of all responsible for production planning and manufacture to obtained a high level of quality conformity the measure of truthfulness with which the product conform to the design specifications.

Factor controlling quality of conformance for good quality of conformance with the design any organization should ensure that-

- The incoming raw materials are of the adequate quality.
- The machine and tool for the job and the measuring instrument are adequate for their purpose and are kept at high level of maintenance
- Proper selected of the process and adequate Process control.
- The operator should be well trained and experience.
- Proper care should be taken in shipments and storages of finished goods.
- Inspection program is such that it gives accurate measure of the efficiency of whole system.

- Feedback from both the internal inspection and the customer are obtained regarding quality for taking corrective action.
- Higher quality of design usually cost more higher quality of conformance usually costs less by reducing the number of defective product produced.

Quality of performance: (performance of design) the quality of performance is concern with how well the manufactured product gives it performance .it depends upon.

- a) Quality of design
- b) Quality of conformance

It can be best design possible but poor conformance control can cause poor performance conversely the best conformance control cannot make the product function correctly, if the design itself is not right.

The quality function

The survival of company depend on the income it getsfrom selling its products and series and the ability to sell is based on fitness for use hence , the company functions concerned with quality or achieve fitness for use are known as quality function. It includes variety of the activities. Everyone working in the factory or all department are responsible for the broad quality function. With the aid market of survey, a company determine what quality are needed by the customer research and development specialist grade a production concept which can meet these quality needs of the users. Design engineer prepare product and material specifications considering the quality requirements. Process engineer specify the process, machine and instrument capable of producing the product with the desired quality, and inspecting them.

Purchasing specialist buy materials and components processing appropriate quality. Operator are trained to use the process and instrument to make the product as per the design. inspector examine the product to judge conformance with the design consumers use the product the experience of use become the basis for a redesign ,or improvement in the product which starts th cycle all over again.

Unit 2- Quality control

HISTORY:

Humans needs for quality have existed the since the Dawn of history , however the means for meeting those needs the process of managing for quality have undergone extensive and continuing change , some of the ancient principle used in the 19th century were:

-Product inspection by consumer which is still widely use on villages market places.

-The craftsmanship concept in which buyers rely on the skill and reputation of craftsman.

In industrial revolution, which originated in Europe, created the factory System. The craftsman become factory workers quality was managed through the skill of the craftsman supplemented by supervisor inspection. The industrial revolution also resulted in additional means i.e.

-Written specifications for material finished goods and inspection criteria.

-Measurements and associate instrument the inspection was largely confined to being a post production activity. The system was applied to inspection of incoming goods, manufactured components and assemblies at appropriate point in the manufacturing process goods or product which did not confirm to specifications were scraped, reworked or passed on concessions was more of screening process with no prevention content.

During world war 2nd European and American industry was face with the added burden of producing enormous quantities of military products. It saw emergency of new concept in management including quality management.

Most of the companies changed the inspection department into quality control quality engineering quality assurance and so forth. As thongs settled down, the engineering manufacturing Department adopted the concept of quality assurance.

In contained all those planned and systematic actions required to provide adequate confidence that a product or service would satisfied given requirements for quality, this concept was largely based on process compliance.

Where the process was viewed comprising of 7 Ms i.e.

Men	Material	Machine	Methods	Methods	Measurements	Money
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The inspection was in the form of monitoring measurements of process at vital points. Which later come to be known as in process inspection. This era of quality assurance also mode use of statistical process control and reliability engineering.

Meaning of quality control

The terms of quality control has variety of meaning.

1) It is a systematic control of various factor that affect the quality of the product, it depends on material, tools, machine type of labor working condition, measurements instruments etc.

2) Quality control can be defined as the entire collection of activities which ensure that operation will produced the optimum quality products at minimum cost.

3) It can also be defined as the tools, device or skill through which quality activities are carried out.

4) It is the name of the department which devotes itself full time to quality function.

5) it is a system ,plan or methods of approach to the solution of quality problems.

6. As per AY Feigorbauon Total Quality Control is “An effective system for integrating the quality development quality maintenance and quality improvement efforts of the various groups in an organization , so as to enable production and services at the most economical levels which allow full customer satisfaction”.

Steps in quality control program:

1. Formulate quality policy.
2. Work out details of product requirement, set the standards (specifications) on the basis of customer's preference, cost and profit.
3. Select inspection plan and set up procedure for checking.
4. Detect deviation from set standards or specifications.
5. Take corrective action through proper authority and make necessary changes to achieve standards.
6. Decide on salvage method i.e. to decide how the defective parts are disposed off entire scrap or rework.
7. Co-ordination of quality problems.
8. Developing quality consciousness in the organization, quality control is not a function of any single department and a person. It is the primary responsibility of any supervisor to turn out of acceptable quality.

Aims or objectives of quality control:

1. To improve the company's income by making the products more acceptable to the customer, by providing long life, greater usefulness, aesthetic aspects, maintainability etc.
2. To reduce company's cost through reduction of losses due to defects. For example to achieve lower scrap, less work, less sorting, fewer customer returns etc.
3. To achieve interchangeability of manufactured in large scale production.
4. To produce optimum quality at minimum price.
5. To ensure satisfaction of customers with products or services of high quality level to build customer goodwill, confidence and reputation of manufacturer.
6. To make inspection prompt to ensure quality control.

Advantages of quality control:

1. Reduction in total cost through less scrap, less rework, less sorting and fewer customer return.
2. To reduce cost for inspection.
3. To reduce cost of production by using proper raw material and operator.
4. Quality standard can be set.
5. Data and technical knowhow is available for development of design of product.
6. Quality and design standard are available at minimum cost.
7. Feedback system enable engineers and operators to take corrective action and preventive action to improve the products.
8. Possibilities of rejection is reduced.

9. Increase in production capacity.
10. Confidence of operator increase which helps in increase of production.
11. Rejection and goodwill of company increases

Functions of Quality Control Department

1. To set quality control standard for various products.
2. To set correct root for achieving better quality of product.
3. To set inspection procedure for various products as per the requirement of industry.
4. Work to maintain quality standard.
5. To find out reason for downfall in quality of products.
6. To fix up responsibility in downfall of quality of product.
7. Motivate workers for quality work.
8. To help purchase department in purchasing raw material of better quality.
9. To help sales department by selling and controlling quality standards of products.
10. To organize training program for inspection.
11. Receive customer complaints and exercise to solve them.
12. Find out the down capacity of various machine and processes in workshop and set quality standards for them.
13. Find out the reason in downfall of quality of products an account of machine and processes and take corrective and preventive action accordingly.
14. To collect all the records regarding inspection so that the same can be used as and when required.

QUALITY CIRCLE

QUALITY CIRCLE is a small group of employees (8-10) working at one place, who come forward voluntarily and discuss their work related problems one in a work (say)for one hour. Workers meet as a group and utilize their inherent ability to think for themselves for identifying the constraints being faced by them pooling their wisdom for final solution that would improve their work life in general and contribute towards better results for the organization.

Characteristics of Quality Circle

- a. It is a philosophy as against techniques.
 1. It harmonizes the work.
 2. It removes barrier of mistrust.
 3. It makes workplace meaning ful.
 4. It shows concern for the total person
- b. It is volunteer.
- c. It is participative.
- d. It is group activity.
- e. It has management support.

- f. It involves task performance.
- g. It is not a forum to discuss demands or grievances.
- h. It is not a forum for management to unload all their problems.
- i. It is not a substitute for joint plant councils or work committees.
- j. It is not a panacea for all ills.

Objective of Quality Circle:

1. To make use of brain power of employees also in addition to their hand and feed.
2. To improve mutual trust between management and employee / unions.
3. To promote participative culture which is the essence of quality circle concept.
4. To improve quality of the organizations.

Benefits from Quality Circle:

1. Improvement in quality.
2. Increase in productivity.
3. Better housekeeping.
4. Cost reduction.
5. Increase safety.
6. Working without tension.
7. Better communication.
8. Effective team work.
9. Better human relation.
10. Greater sense of belongingness.
11. Better mutual trust.
12. Development of participative culture.

Starting a quality circle

Step 1- Explain the employee What is quality circle and what possibly can be achieved by it.

Step 2-Form a quality circle of

1. About 8-10 employees.
2. Working at the same area.
3. Have the same wavelength and.
4. Who are interested to join the quality circle voluntarily?

Step 3 –

a) First meeting

1. Choose team leader and deputy leader
2. Doubts of employee, if any will be removed in this meeting.

b) Second meeting

1. List all problems.
2. Identify the problems to be taken first.
3. Conduct brain storming session.
4. Leaders keeps on recording the minutes.

c) Third meeting and onwards

1. Problem analysis by members.
2. Study of cause and effects relation for example, if two machines are booked after by one worker what good or bad will happen.
3. Solution recommended.

Quality Characteristics

A physical or chemical property, a dimension, a temperature, pressure, taste smell or any other requirement used to define the nature of the product or service is a quality characteristics .Thus a metal cylinder may be defined by stating the quality characteristics .Such as the type of metal, the length, the diameter etc. The quality characteristics contributes to fitness for use of the product.

Cost of Quality

The cost of carrying out the company's quality functions (meeting the quality needs of the customers) are known as costs of quality. This includes

1. Market research costs of discovering the quality needs of the customers.
2. The product research and development costs of creating a product concept which will meet these quality needs.
3. The design costs of translating the product concept into information which permits planning for manufacture.
4. The costs of manufacturing planning in order to meet required quality specifications.
5. Costs of inspection and tests.
6. Costs of defect prevention.
7. Costs of scrap, quality failure.
8. Cost of quality assurance.
9. Field services and such other factors attributed to the quality improvement and maintenance.

STATISTICAL QUALITY CONTROL

Statistics means data, a good amount of data to obtain reliable results. The science of statistics handles this data in order to draw certain conclusions. Statistical technique finds extensive application in quality control, production planning and control, business charts, linear programming etc.

A quality control system perform inspection, testing and analysis to conclude whether the quality of each product is as per laid quality standards or not. It is called statistical quality control when statistical techniques are employed to control quality or to solve quality control problems. Statistical quality control makes inspection more reliable and at the same time less costly. It controls the quality level of outgoing products.

Using statistical techniques SQC collects and analyses data in assessing and controlling product quality. The technique of SQC was though developed in 1924, it got recognition in industry only during Second World War.SQC permits amore fundamental control. It scientifically fixes the process tolerances.

The fundamental basis of statistical quality control system is the theory of probability. According to the theory of probability, the dimensions of the components made on the same machine and in one batch (if measured accurately) vary from components to components. This may be due to inherent machine characteristics or the environmental conditions. The chance that a sample will represent the entire batch or population is developed from the theory of probability. Problems that cannot be expressed in data are not solved by SQC technique. In the system first of all the data related to problem are collected and this should be done very carefully as the result of SQC depends on them. A single error can change the result. Second step under SQC is to analyze the data. For quality control use SQC and control chart methods. Various control charts are XR chart, P chart, C chart.

Statistical quality control is systematic as compared to guess work of haphazard process inspection, and mathematical. Statistical approach neutralize personal bias and uncovers poor judgment.

Statistical method can be used in arriving at proper specification limits of products, in the purchase of raw material, semi-finished and finished products, manufacturing processes, inspection, packaging, sales and also sales services.

Advantages of statistical quality

1. Deviation in quality during manufacturing processes can be easily find out.
2. Information can be easily collected while corrective or preventive action of any problem.
3. Quality standard can be find out and same can be set.
4. Workers take interest in method.
5. Supervision work can be minimized.
6. Capacity of machine and processes for administrative control can be obtain.
7. Keep reducing scrap, reclamation work .Hence labour and money saved.
8. Both worker and supervisor work very carefully.
9. The use of SQC ensures rapid and efficient inspection at minimum cost.
10. Increased out and reduced wasted machine and man hours.
11. Efficient utilization of personnel, machine and material resulting in higher productivity.
12. Better customer relation through general improvement in product and higher share of market.
13. Elimination of bottlenecks in the process of manufacturing.
14. Creating quality awareness in employees.

DIFFERENCE BETWEEN INSPECTION AND QUALITY CONTROL

Quality control should not be confused with inspection. Inspection means checking material, product or component of product at various stages with reference to certain predetermined factors and detecting and sorting out the faulty and defective items. In inspection activity the emphasis is placed on the quality of the past production. To illustrate , if the production schedule calls for manufacturing 1000 rods with a diameter of 25 ± 0.005 mm. The inspector will concern himself only with whether the rod s produced meet this specification.

Those that do not, will be rejected and will continue until 1000 good units have been produced.

Quality control is a broad term, it involves inspection at particular stage but more inspection does not mean quality emphasis is placed on the quality of future production. There are various ways of doing this. For example, care may be taken to provide operating personnel with correct instructions prior to the production of an item. However, one of the more important way is based on technique of statistical nature. For example to return to our illustration, as the rods are being produced, periodic samples might be taken of the output and the rods in each sample inspected. If the quality of the item in a particular sample is satisfactory, production will be allowed to continue. But if it is not, corrective action will be immediately take. This action might involve adjusting the machine eliminating defects in the raw material, instructing or replacing the operator etc.

Hence, in short, in inspection quality of past production is ascertained and quality inspection is merely an act of checking and sorting put the defective items whereas quality control is broad term which includes number of activities (including inspection) in order to build up and regulate the quality of product.

Unit 3 Integrated Management System

What is an Integrated Management System

An Integrated Management System (IMS) integrates all of an organization's systems and processes in to one complete framework, enabling an organization to work as a single unit with unified objectives.

Organizations often focus on management systems individually, often in silos and sometimes even in conflict. A quality team is concerned with the QMS, often an EHS manager handles both Environmental and Health and Safety issues, etc.

Integrated Management Systems:



QMS - Quality Management System

A quality management system (QMS) is a set of policies, processes and procedures required for planning and execution (production/development/service) in the core business area of an organization. (i.e. areas that can impact the organization's ability to meet customer requirements.) ISO 9001:2015 is an example of a Quality Management System.

EMS - Environmental Management System

An Environmental Management System (EMS) determines and continuously improves an organizations' environmental position and performance.

- [ISO 14001 Environmental Management Systems](#)

SMS - Safety Management System

An OHSMS determines and continually improves an organizations Health and Safety position and performance. It follows an outline and is managed like any other facet of a business, such as with marketing or engineering functions.

- [OHSAS 18001 Occupational Health and Safety Management Systems](#)

EnMS - Energy Management System

An EnMS determines and continually improves and organizations' energy usage and impact.

- [ISO 50001 Energy Management System](#)

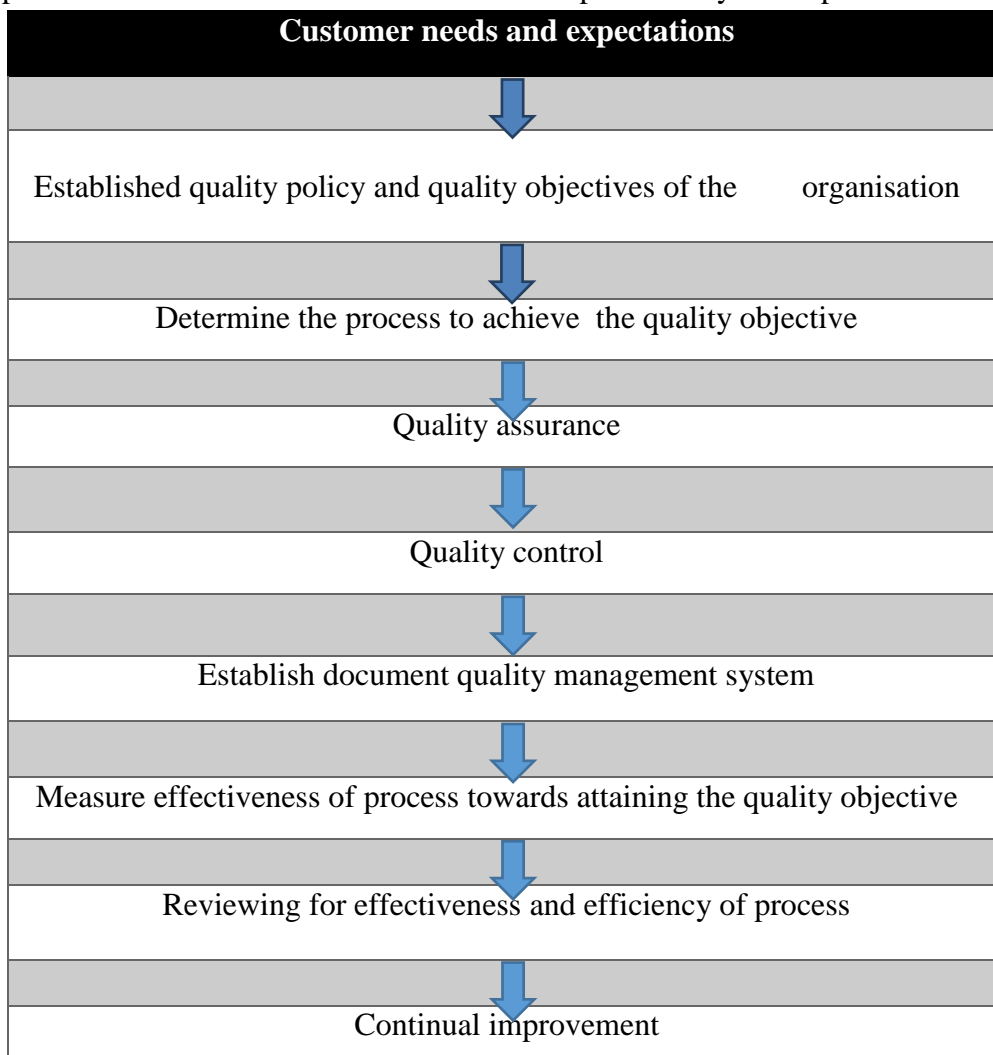
Quality management system

ISO 9000: 2015 defines “Quality management system” as system to established quality policy and quality objectives and to achieve those objectives. ISO 9000 family of

standard distinguish between requirements for quality management systems and requirements for products. Requirement for quality management system are specified in ISO 9000. These are generic and could apply to any organisation regardless of nature of product or service. ISO 9000 itself does not establish requirements for products.

Why do we need Quality management system: –In today’s competitive environment, it is not quality at any cost, instead it is quality of competitive cost. In this context Quality management system provides the right framework for organisation to harness there capabilities and basis the efforts to achieve the intended business result and serve as a basis for long term group and survival.

Key objects for Quality management system to have effective management of internal process to – Enhance costumer/stack holder satisfaction to sustain business competitive ness. Increase bottom line result and profitability with optimum use of resource.



International organisation for standardisation (ISO)-: The International organisation for standardisation is a worldwide federation national standards bodies, one from each of approximately 130 countries. ISO was duly formed and began its official function on 23rd February 1947. ISO is a non-governmental organisation which now sees its mission as the promotion of the development of standardisation and related activities in the world with a view to facilitating the international exchange of goods and services and developing corporations in the sphere of intellectual, scientific, technological and

economic activity. Its work results in international agreements, which are international standards.

Till recently there were some 20 standards in the ISO 9000 family. This revised series has only four core standards-

ISO 9000 is for concept and terminology.

ISO 9001 is for requirement of quality management.

ISO 9004 is for guidance of quality management of organisations. ISO 19011 guidelines on quality and environmental auditing.

Advantages of ISO 9000:2015-Adopting ISO 9000 series of standards offer number of advantage to all stakeholders including suppliers, customers, employees of the organisation etc. some of these advantages are stated below: It helps in setting house in order; it brings clarity in all operation that is what is to be done, by whom, how and established criteria for all processes. There is less of fire-fighting and employees are encouraged to be pro-active. The costumers feel more confident, with the organisation having quality management system, as it provides them with visibility and verifiability about the organisation, its system and even products. The certified organisation gets mention in important product guides, directories and attracts more business. This is more so with oversees client, who for the obvious reasons, insist on ISO 9000 certificate. Documented quality system, based on requirements of ISO 9000, as a minimum helps organisation in being consistence. In fact threw measurement and maintaining the costumer's satisfaction, regular internal audits, monitoring of measuring process and products and management reviews, there is all-round improvement. Once system sets in, it institutionalises the process of continual improvement in real business terms. Like in any good dynamic quality management system, the employees' of ISO 9000 organisation has greater opportunities of learning and contributing, this helps them to satisfy their esteem needs, bringing positive and enjoying work culture in the organisation.

Some abbreviation in QMS:-

- ISO- International Organisation for Standardisation
- QMS- Quality Management System
- EMS – Environmental Management System
- CEO - Chief Executive officer
- MR- Management Representative
- QU – Quality Unit
- FU – Functional Unit
- MRM - Management Review Meeting
- IQA – Internal Quality Audit
- CA & PA – Corrective Action & Preventive Action
- QM – Quality Manual

- QSP – Quality Standard Procedure
- QP – Quality Plan
- WI – Work Instruction
- IMPTE – Inspection Measuring & Testing Equipment
- FMEA – Failure Mode & Effective Analysis
- HRD – Human Resource Development
- TQM – Total Quality Management
- FIPO – For Indication Purpose Only
- NO – Non Conforming

Genesis of ISO 9001: 2015 is described in the flow chart given below:-

□ Plan what you do

- Defining scope of business in term of products & services & related supportive functions
- Defining process for realising the scope.
- Justify what you plan
- Organisation should look into process in terms of 7 M's (men, method, machine, material, measurement, milieu, money) their sequence and interaction and documents then as process maps. All process is based on respective criteria to minimised subjectivity, requirements of ISO 9001:2015 are designed for this very purpose. Ensure that these requirements are addressed within the documented system.
- Do what you planned
- Process and their interaction, need to be communicated to all process owners.
Documented system are established and implemented at all levels.
- Have evidence that you have been doing, as planned.
- Organisation needs to demonstrate compliance of documentation system through objective evidence or quality records.
- Review what you did
- Management to review the effectiveness of system vice-versa quality objectives.
- Modify what you should
- Based on the management review, planned for corrective and preventive actions, bring modification in the procedure, process and system.
- Go back to step- 1
- Institutionalise the process of continuous improvement.

Quality management principles: Quality management system based on ISO 9001:2008, should have good look at those principles, to achieve best results:-

□ Customer focused organisation

- Leadership
- Involvement of people
- Process approach

- System approach To management
- Continual improvement
- Factual approach to decision making
- Mutually beneficial supplier relationship

Principle 1. Customer focused organisation:-

This principle calls for building customer oriented organisation. This is largely possible through empowerment. Front line employees are to be empowered mostly as they are dealing with the external customers on one basis. Organisation should deploy means to understand present and futuristic needs of customers in respect of products, delivery, price etc. these needs should get communicated through organisation. In short the organisation becomes functionally a customer driven organisation. To close the loop, customer satisfaction is measured and taken as feedback to improve upon and even exceed the customer expectation.

Principle 2. Leadership:-

Quality initiatives will succeed only in case these are led by top management. Leadership is to be developed through “knowledge & charisma”. Organisation should be lay emphasis on developing leadership among senior management who are expected to be a role model of the employees. CEO should build shared vision, which could be own by all employees. Leadership in natural p process builds team work, trust and believe among people. Leader should empower, facilitate, inspire and recognise people to achieve challenging goals and targets which motivate people to take ownership of processes.

Principle 3. Involvement of people:-

In quality organisation, people are always in learning mode. They use learning as value addition of process and of their own. Leadership and costumer orientation coupled with learning environment are time tested ingredients for people to take ownership. These are the people, enjoy the same and are proud to be part of the organisation.

Principle 4. Process approach:-

Process are not set of procedures and work instructions, the organisation should define the process in terms of 7 Ms (Men, Method, Machine, Material, Milieu, Measurement, Money) this would mean designing and making available these Ms. It is important that organisation identify interference of internal processes for smooth integration and achieving efficiency and effectiveness. This calls for identifying internal costumer, their needs, similarly as done for external costumers.

Principle 5. System approach to management:-

It's important to understand and dependencies among the processes of the system or system approach means; looking in to inter-relation of processes rather than linear cause effect chains. "The essential properties that describe any system are properties of the whole which none of its parts have, for e.g. The essential property of an automobile is that it can take you from one place to another. No single part of an automobile- a wheel, an axle, and carburetor can do that. An automobile is not the sum of its parts; it's the product of their interactions."

Principle 6. Continual improvement:-

QMS have in- build clauses which call for continuous improvement through corrective/prevention actions, internal audits and management review. These at times look at improvement on piece-metal basis. Continual improvement on other hand call for improvement process to become Norm that is institutionalised where organisation promote prevention based activities, provide every member with appropriate education & training on the methods and tools of continual improvement.

Principle 7. Factual approach to decision making:-

This principle requires organisation to manage the information, making decisions and taking actions, based on the results of logical analysis. Organisation should make of use appropriate statistical techniques to monitor product characteristics and process capability. Competitive process benchmarking, measuring cost of quality, measuring customer satisfaction and similar interventions can help organisation to have factual approach to decision making.

Principle 8. Mutually beneficial supplier relationship:-

This also means, creating and managing supplier relationship to ensure reliable, on time, defect free delivery of supplies, this principle calls for identification and selection of suppliers based on sound principles of quality management system i.e. by accessing their capabilities for short term gains and long term considerations. Organisation should encourage supplier to implement continual improvement programmes.

ISO 14001 - Environmental Management System

The **ISO 14001 Certification** is an Environmental Management System (EMS) Standards – This standard provided the requirement of EMS and guideline for use. The ISO 14001 standard is a specific standard for Environmental Management system. The ISO 14001 (EMS) is applicable to any organization that wishes to demonstrate sound environmental performance of the organization by controlling the impacts of their activities, products and services on the environment, consistent with their environmental policy and objectives and Complying with applicable legal and regulatory requirements.

The summarized requirement details of ISO 14001 are given below :

General Requirements of Environmental Management System

Which include the requirement of – development, documentation, implementation of organization Environmental Management System as per ISO 14001 requirement.

Environmental Policy

The organization shall develop the environmental policy, which includes the top management commitments to continual improvement, prevention of pollution, comply with applicable legal requirements and other requirements to which the organization subscribes which relate to its environmental aspects. The organization's environmental policy is being communicated to all stake holders and is available to public.

Planning

Which include the requirement of – identification of Environmental aspects and their impacts and determination of significant environmental aspects, applicable legal and other requirements, objectives, targets and programme(s).

Implementation and Operation

Which include the requirement of – setting up of Resources, roles, responsibility and authority in relation with EMS requirements, determination of Competence, providing training and awareness on Environmental management system requirements, Communication, Documentation, Control of documents, setting up of the Operational control to reduce the environmental impact, determination of potential emergency situations and establishing the Emergency preparedness and response.

Checking

Monitoring and measurement of environmental performance (significant aspects and EMS objectives & targets), Evaluation of compliance, Nonconformity, corrective action and preventive action, Control of records, internal audit.

Management Review

Which include the requirement of - conduct the Management review meeting on environmental management system, at planned intervals, to ensure its continuing suitability, adequacy and effectiveness. And assessing opportunities for continual improvement identify any need for changes to the environmental management system, environmental policy and environmental objectives and targets.

Benefits of ISO 14001 Certification

- Improve the environmental performance of the organization.
- Environmental pollution reduced.
- Compliance with Legal and regulatory requirements related to Environment.
- Awareness about preparedness of potential Emergency situation.
- Improve the business potential among the competitor.
- Reduce wastage of Energy, natural resources, Raw materials.
- Operation control over the process shall improve.

- Commitment to Nation towards reduction pollution and compliance with legal regulatory requirement shall improve.

Applicant organization shall ensure the followings prior to ISO 14001 Certification (Environmental Management System Certification)

- Implementation of Environmental Management System in the organization. Established the Quality Manual, relevant procedures and SOP's
- Conducted one complete cycle Environmental Management System Internal Audit.
- Conducted at least one Management review meeting on Environmental Management System.
- Applicable Legal requirements related to Environmental management system have been identified and compliance has been established.
- Significant Environmental Aspects has been identified and its operational control has been implemented.
- Potential Environmental emergency situation has been identified and its preparedness has been established.

ISO 14001 - Environmental Management System Certification Process

- Application review and contract Sign up between OSS and applicant organization.
- Stage-1 Audit.
- Stage-2 Audit.
- Certification decision.
- Issue of certificate.
- Surveillance audit (annually or Half yearly as finalized during application review process and agreed by client).
- Re-Certification Audit (within three years before expiry of certificate).

OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM

OHSAS 18001 has been developed to be compatible with ISO 9001:2008 (Quality) and ISO 14001:2004 (Environmental) management systems standards, in order to facilitate the integration of quality, environmental and occupational health and safety management systems by organisations, should they wish to do so.

Organisations of all kinds are increasingly concerned with achieving and demonstrating sound occupational health and safety (OH&S) performance by controlling their OH&S risks, consistent with their policy and objectives. They do so in the context of increasingly stringent legislation, the development of policies and other measures that foster good OH&S practices.

The advantages of an effective OHSAS management system:

- > • Provides a structured approach for managing OH&S
- > • Establishes and maintains a commitment to occupational health and safety
- > • Demonstrates strong commitment to safety excellence

- > • Organisational structures in place with clear roles and responsibilities
- > • Existence of a continuous improvement culture
- > • Strong levels of trust and communication
- > • Reduction in incident levels with increased measures of performance.
- > • Contributes to business performance by reducing cost and liabilities.

Occupational Health and Safety is based on:

Hazard identification

- The process of recognizing that a hazard exists (source or situation with the potential to cause harm in terms of human injury or ill-health)

Risk assessment

- The process of evaluating the risk arising from the hazard (combination of the likelihood of a hazardous event or exposure and the severity of injury or ill health that can be caused by the event of exposure)

Determination of applicable controls

- Measures relevant to eliminate or reduce risk to an acceptable level. Measures are based on the hierarchy of control measures.

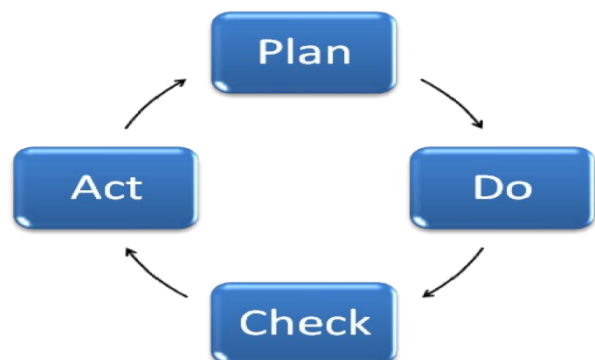
In order to achieve an effective health and safety system it is vital for organizations to handle these with greater significance. The three aspects above provide the ever important foundation for implementing OHSAS 18001 and without them, the overall system would surely fail. They are, theoretically, considered a part of the ‘PLAN’ step (explained later), but most auditors and consultants agree that these aspects should be dealt with before designing the system as a whole.

OHSAS 18001 Occupational Health and Safety Standard uses a management approach tool called the PDCA cycle. PDCA is an ongoing process that enables an organisation to establish, implement and maintain its health and safety policy based on top management leadership and commitment to the safety management system. It consists of the following:

Plan – establish the objectives and processes necessary to deliver results in accordance with the organisation’s OH&S policy

Do –implement the process

Check –monitor and measure performance against OH&S policy, objectives, legal and other requirements, and report results



Act – take actions to continually improve OH&S performance

The standard can be implemented to your whole organization or to just a part of it. The best results though come when the whole organization is working on the same system and OH&S policy is integrated into other management systems and into the culture of the organization.

Plan

The planning stage of the process requires the organization to:

- > • Devise an OH&S policy
- > • Plan for hazard identification, risk assessment and determination of controls
- > • Identify relevant legal requirements
- > • Plan for emergencies and responses
- > • Manage change effectively
- > • Devise procedures for performance measuring, monitoring and improvement
- > • Provide and ensure the appropriate use of safety equipment
- > • Train in order to introduce an OH&S culture and establish the importance of organization's safety statement, policies and objectives
- > • Consult employees and communicate

At first, the management has to be consulted in order for them to feel confident in supporting the new system and constantly driving it forward. Then the workforce has to be consulted. It is very likely that the lower level employees have valuable insight, ideas and feedback about the new system. Since they are the ones that are going to be most affected by it, it is logical to ensure they believe and understand the need for change. Failure to realize this could result into much resistance throughout your organization and thus result in a system that is impractical to operate.

Do

The implementation stage should be the easiest part of this process. If the planning stage is done the right way then it is just a matter of following the documentation and procedures that have been created. In order to ensure smooth implementation a lead senior manager should be in charge of the new OH&S system and at the same time each element of the process should have an 'owner' or a person that looks after that part of the system. This ensures the appropriate structure at your organization and effectively minimizes risk.

It is advisable to start the implementation by breaking the system down into specific elements rather than tackling it as a whole. Concentrating on specific elements in a logical order creates a solid foundation for the whole system to work efficiently.

Another important aspect of health and safety is having employees do the jobs that are suited to their competencies. A matrix should be created showing all groups of personnel, their required competencies, training and status of each. These formal procedures should instill the required awareness within your organization.

Check

The third step of the PDCA cycle consists of the following:

- > • Conducting internal audits
- > • Evaluation of legal compliance
- > • Identifying non-conformities and addressing them
- > • Thorough analysis of incidents and incidental data
- > Measuring performance and monitoring

The failure to conduct internal audits periodically will most likely result in the breakdown of the system as a whole. It often happens that where there is no control, risks tend to arise especially quickly.

Any arising non-conformities should be tackled instantly using the devised corrective actions. The most effective and robust systems ensure that this process runs smoothly at all times. This means that the performance of this process should be measured as well and any non-conformities have to be dealt with. It is not only the arising non-conformities that your organization needs to think about. It's crucial for your organization to identify any possible emergencies and develop relevant response procedures, this is called preventative action.

When devising controls and measuring performance it is important to strike a balance between being overly bureaucratic and overly light on certain elements of the system. The OHSAS 18001 Occupational Health and Safety Management Specification is not supposed to hinder the performance of your organization but improve it.

Act

The final step is the management review, it is a vital part of the continuous improvement process and so the standard itself outlines what should be included in such a review.

Management review is done by the senior management and involves reviewing the suitability, adequacy and effectiveness of the system. It should also include assessing opportunities for improvement and the necessity to change the OH&S policy and the OH&S objectives. If changes are needed, the senior management should also provide the necessary resources for their implementation. Providing resources is a way of presenting commitment to the new health and safety system.

ISO- 50001:2011 : ENERGY MANAGEMENT SYSTEM

Introduction

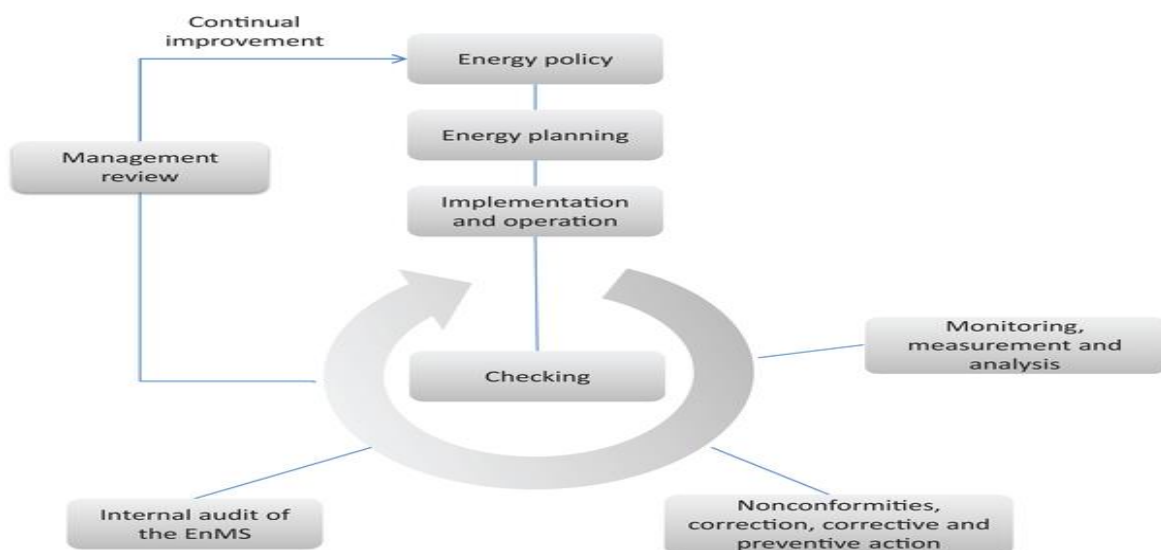
The purpose of this International Standard is to enable organizations to establish the systems and processes necessary to improve energy performance, including energy efficiency, use and consumption. Implementation of this International Standard is intended to lead to reductions in greenhouse gas emissions and other related environmental impacts and energy cost through systematic management of energy. This International Standard is applicable to all types and sizes of organizations, irrespective of geographical, cultural or social conditions. Successful implementation depends on commitment from all levels and functions of the organization, and especially from top management.

This International Standard is based on the Plan - Do - Check - Act (PDCA) continual improvement framework and incorporates energy management into everyday organizational practices, as illustrated in [Figure 1](#).

NOTE In the context of energy management, the PDCA approach can be outlined as follows:

- — Plan: conduct the energy review and establish the baseline, energy performance indicators (EnPIs), objectives, targets and action plans necessary to deliver results that will improve energy performance in accordance with the organization's energy policy;
- — Do: implement the energy management action plans;
- — Check: monitor and measure processes and the key characteristics of operations that determine energy performance against the energy policy and objectives, and report the results;
- — Act: take actions to continually improve energy performance and the EnMS.

Figure 1 — Energy management system model for this International Standard



Worldwide application of this International Standard contributes to more efficient use of available energy sources, to enhanced competitiveness and to reducing greenhouse gas emissions and other related environmental impacts. This International Standard is applicable irrespective of the types of energy used.

This International Standard can be used for certification, registration and self-declaration of an organization's EnMS. It does not establish absolute requirements for energy performance beyond the commitments in the energy policy of the organization and its obligation to comply with applicable legal requirements and other requirements. Thus, two organizations carrying out similar operations, but having different energy performance, can both conform to its requirements.

This International Standard is based on the common elements of ISO management system standards, ensuring a high level of compatibility notably with [ISO 9001](#) and [ISO 14001](#).

NOTE [Annex B](#) shows the relationship between this International Standard and [ISO 9001:2015](#), [ISO 14001:2004](#) and [ISO 22000:2005](#).

1 Scope

This International Standard specifies requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy use and consumption.

This International Standard is applicable to any organization wishing to ensure that it conforms to its stated energy policy and wishing to demonstrate this to others, such conformity being confirmed either by means of self-evaluation and self-declaration of conformity, or by certification of the energy management system by an external organization.

2 Normative references

No normative references are cited. This clause is included in order to retain clause numbering identical with other ISO management system standards.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Boundaries

physical or site limits and/or organizational limits as defined by the organization

3.2 Continual improvement

recurring process which results in enhancement of energy performance and the energy management system

3.3 Correction

action to eliminate a detected [nonconformity \(3.21\)](#)

3.4 Corrective action

action to eliminate the cause of a detected [nonconformity \(3.21\)](#)

3.5 Energy

electricity, fuels, steam, heat, compressed air, and other like media

3.6 Energy baseline

quantitative reference(s) providing a basis for comparison of energy performance

3.7 Energy consumption

quantity of energy applied

3.8 Energy efficiency

ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

EXAMPLE:

Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

3.9 Energy management system

EnMS

set of interrelated or interacting elements to establish an energy policy and energy objectives, and processes and procedures to achieve those objectives

3.10 Energy management team

person(s) responsible for effective implementation of the energy management system activities and for delivering energy performance improvements

3.11 Energy objective

specified outcome or achievement set to meet the organization's energy policy related to improved energy performance

3.12 Energy performance

measurable results related to [energy efficiency \(3.8\)](#), [energy use \(3.18\)](#) and [energy consumption \(3.7\)](#)

3.13 Energy performance indicator

EnPI

quantitative value or measure of energy performance, as defined by the organization

Note 1 to entry: EnPIs could be expressed as a simple metric, ratio or a more complex model.

3.14 Energy policy

statement by the organization of its overall intentions and direction of an organization related to its energy performance, as formally expressed by top management

3.15 Energy review

determination of the organization's energy performance based on data and other information, leading to identification of opportunities for improvement

3.16 Energy services

activities and their results related to the provision and/or use of energy

3.17 Energy target

detailed and quantifiable energy performance requirement, applicable to the organization or parts thereof, that arises from the energy objective and that needs to be set and met in order to achieve this objective

3.18 Energy use

manner or kind of application of energy

EXAMPLE:

Ventilation; lighting; heating; cooling; transportation; processes; production lines.

3.19 Interested party

person or group concerned with, or affected by, the energy performance of the organization

3.20 Internal audit

systematic, independent and documented process for obtaining evidence and evaluating it objectively in order to determine the extent to which requirements are fulfilled

3.21 Nonconformity

non- fulfillment of a requirement

[SOURCE: ISO 9000:2005, definition 3.6.2]

3.22 Organization

company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration and that has the authority to control its energy use and consumption

3.23 Preventive action

action to eliminate the cause of a potential [nonconformity \(3.21\)](#)

3.24 Procedure

specified way to carry out an activity or a process

3.25 Record

document stating results achieved or providing evidence of activities performed

3.26 Scope

extent of activities, facilities and decisions that the organization addresses through an EnMS, which can include several boundaries

3.27 Significant energy use

energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement

3.28 Top management

person or group of people who directs and controls an organization at the highest level

Unit 4 Total Quality Management

(Going beyond ISO 9000)

Of late, there has been an increasing feeling among the users of ISO 9000 standard that the standard are not prompting the user organization to improve the quality of their products, process and system .Many feel that even after implementation of quality system there is no perceptible change within the organization and activities process and results appear to remain as they were earlier, the generic confusion seems to have left the implementing organization wondering whether:

- They have correctly understand and implement the quality of system or
- Consultants have quoted properly or
- Certification body is doing its job adequately or
- The ISO 9000 standard itself focus in its contents

This is precisely because users of the standard gave excessive emphasis on demonstration rather than managing process and achievements of quality. Largely system were built to satisfy auditor/certification agencies and precious effort were directed more towards the demonstrability aspects, through demonstration.

The standard now focus on continually increasing the effectiveness and efficiency of the organization or step towards TQM.

Definition: ISO 8402 define total quality management as a “management approach of an organization centered on quality, based on the participation of all its, member and aiming at all its member of the organization and to society” TQM is an evolving system of practices, tools, and training methods being developed primarily by industry, for creating higher quality products and services for increased customer satisfaction in a rapidly changing world

1. Four principle of leadership: customer focused; continuous improvement; basically process oriented; total participation, society
2. A quality system and system thinking as a basis for quality management.
3. A total box for efficient and effective quality (process and product) control, assurance, improvement (continuous) and innovation (breakthrough) process, product and system

Total quality management is thus an ongoing journey of continuous measurable improvement, championed by empowered individual at all levels of the organization The organization leadership inspires teamwork and a sincere' trust and beliefs' in people which results in an enjoyable and productive work place, dedicated to the highest possible level of customer satisfaction

Incorporates the key words and depicts TQM in the form of a house, comprising of quality system as foundation, three pillars built in form of

- Leadership and management commitment
- Team work and employees involvement
- Rules and techniques for continuous improvement

The house can't be complete unless covered by the roof and the TQM house get the roof built in the form of total customer delight. The house model of TQM also symbolizes that as a roof can only be built on pillars. The Total customer delight could only be achieved through the pillars of leadership, teamwork and learning .In short TQM believe in satisfying customer through empowered employees

TQM envisage leadership as that quality in a person induces to follow the leadership and management differ in terms of their primary function. Leadership is to inspire useful change, while management create orderly results working efficiently.

There are four basis aspects, concerning the CEO's leadership role in TQM

1. Building vision
2. Involving everyone in that vision
3. Managing learning
4. Empowering everyone with authority and responsibility

About vision, it must be said that

- Vision without plan and effort results in fantasy
- Plan and effort without vision results in drudgery
- Only vision with plan and effort leads to world class quality

Trademarks and employee involvement

Employee of an organization will function better by applying the same principle of teamwork as are applied in team sports for example: football in a winning team everybody plays for themselves and the team win. Football is about getting the best possible score by mobilization the energy of all players to Score goal and defend the goal. The same apply to an organization that object is to mobilize the energy of all employees to score the organization future.

Two of the important elements of a team are:

- Common objective
- Midterm reviews

In a game of football, there are eleven players having different specialization forward, mid-field we, back and the goalkeeper.

Let's manage that organization is a club , chairman is the coach and employee are the players i.e. senior management as forward , middle level manager as mild field players , supervisor as

back and operator/workers as goal keeper . Let's apply simple test to ascertain whether organization is playing like football team:

- Is there a team spirit within organization
- Are there common objective
- Do all individuals develop and make the most of strong point
- Does everyone feel responsible for the failure and success of the team
- Does everyone play for themselves and for the team to win
- Does organization have midterm review

Tool and techniques for continuous improvement;

A TQM organization is truly a learning organization. Leading companies across the world have show that training is one of the pillars of improvement in quality.

Total quality management believes in following:

- Work to learn
- Work to contribute
- Work to enjoy

Unless you are learning, you cannot be contributing and unless you contributing you cannot be enjoying

Training in TQM: TQM calls for multifunction. This can be achieved by training in the form of

- Finance for non-financial employees
- Computer skill for everyone
- Quality for everyone
- Communication for everyone
- productivity for everyone
- Teamwork for everyone
- Problem solving techniques for everyone

Top rankings companies put in a significant amount of effort in identifying training needs on a continuous basis and address these to develop learning culture. Some of the example in terms of resources put in by them is as follows.

1. Minimum of 10 man days training to each of the employee, every year
2. Earmarking 7% of payroll on training.
- 3.110 hours of training per worker each year on quality improvement techniques
4. Training on customer management for all new employee

Total customer delight:

Form the organization point of view, customer delight is that result of a three part system

1. Company process (operation)
2. Company employee, who delivers the products and services that is consistent with

3. Customers expectations.

Thus the effectiveness of the three part system is a function of how well these three factor are integrated .Shows the shaded area, which is an overlap of the three part system and is a measure of customer satisfaction .The objective is to make this area as large as possible and ultimately to make all the circle converge into an integrated system.

Implementing TQM:

Step by step approach

- It is essential that organization has in place , effective system covering personnel, operations and customer relations management
- The organization has CEO, who believe in principle of TQM and is aware that TQM effort will take 3-4year before take results start showing
- The organization has come out with shared vision and based on which has developed quality policy and quality objective.
- The organization has put in place the HRD practice i.e. organizational, development, performance appraisal, 360 degree feedback etc.HRD audits are conducted on regular basis.
- The quality system is aligned to ISO 9000:2000
- Organization resort to regular benchmarking to generate performance gap and therefore “need for Change”. Quality cost is monitored.
- Midterm review are conducted at department level, project level and then in organization level. Results of review are communicated to all
- Timings multi disciplinary area is institutionalized .These include quality, productivity, customer orientation, behavior, finance, safety, environment etc.
- Quality initiative I.e. kaizen club , quality circle , QITs, quality weeks etc are integrated in the QMS
- People in the organization have subconsciously adopted three golden principle;
 1. Working to learn (adaptive as well as generative learning)
 2. Working to contribute (applying learning for innovation)
 3. Working to enjoy (fulfillment of and self realization needs)

ISO 9000:2000 beard to TQM

QMS based on ISO 9000:2000 provide a sound foundation, on which TQM programme can be built. Implementing ISO 9000:2000 helps to establish the basis process and quality control and which have capability to have the way for continuous improvement. What is important that ISO 9000:2000 be seen a first big step in a TQM programme and certificate .It is therefore vital for the top management to examine the elements of ISO 9000:2000 FOR their wider implications in designing “people oriented(HRD)”, ”customer focused” and “continuous improvement(learning based)” QMS. Management must recognize the strength of system (QMS).

It is said and that it is easier to change system and process than to change people. People adept themselves to the system rather easily. Therefore if ISO 9000:2000 based system incorporating orientation towards people , customer and continual improvement ,are in place ; it is would initiative employees in taking ownership of processes and systems making ISO 9000:2000 AS spring based to TQM

ISO 9000 vs TQM

ISO 9000	TQM
It is a standard	It is culture
Process oriented	Customer oriented
More techniques	More people oriented

Quality Management Systems – Requirements (ISO-9001:2015 (E))

1 Scope

This International Standard specifies requirements for a quality management system when an organization:

- a) Needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and
- b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance

Unit 5 Quality management systems — Requirements

International Standard ISO 9001:2015

1 Scope

This International Standard specifies requirements for a quality management system when an organization:

- a) needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, and
- b) aims to enhance customer satisfaction through the effective application of the system, including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

All the requirements of this International Standard are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides.

NOTE 1 In this International Standard, the terms “product” or “service” only apply to products and services intended for, or required by, a customer.

NOTE 2 Statutory and regulatory requirements can be expressed as legal requirements.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000:2015, *Quality management systems — Fundamentals and vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 9000:2015 apply.

4 Context of the organization

4.1 Understanding the organization and its context

The organization shall determine external and internal issues that are relevant to its purpose and its strategic direction and that affect its ability to achieve the intended result(s) of its quality management system.

The organization shall monitor and review information about these external and internal issues.

NOTE 1 Issues can include positive and negative factors or conditions for consideration.

NOTE 2 Understanding the external context can be facilitated by considering issues arising from legal, technological, competitive, market, cultural, social and economic environments, whether international, national, regional or local.

NOTE 3 Understanding the internal context can be facilitated by considering issues related to values, culture, knowledge and performance of the organization.

Understanding the needs and expectations of interested parties

Due to their effect or potential effect on the organization's ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements, the organization shall determine:

- a) the interested parties that are relevant to the quality management system;
- b) the requirements of these interested parties that are relevant to the quality management system.

The organization shall monitor and review information about these interested parties and their relevant requirements.

Determining the scope of the quality management system

The organization shall determine the boundaries and applicability of the quality management system to establish its scope.

When determining this scope, the organization shall consider:

- a) the external and internal issues referred to in [4.1](#);
- b) the requirements of relevant interested parties referred to in [4.2](#);
- c) the products and services of the organization.

The organization shall apply all the requirements of this International Standard if they are applicable within the determined scope of its quality management system.

The scope of the organization's quality management system shall be available and be maintained as documented information. The scope shall state the types of products and services covered, and provide justification for any requirement of this International Standard that the organization determines is not applicable to the scope of its quality management system.

Conformity to this International Standard may only be claimed if the requirements determined as not being applicable do not affect the organization's ability or responsibility to ensure the conformity of its products and services and the enhancement of customer satisfaction.

Quality management system and its processes

4.4.1 The organization shall establish, implement, maintain and continually improve a quality management system, including the processes needed and their interactions, in accordance with the requirements of this International Standard.

The organization shall determine the processes needed for the quality management system and their application throughout the organization, and shall:

- a) determine the inputs required and the outputs expected from these processes;
- b) determine the sequence and interaction of these processes;
- c) determine and apply the criteria and methods (including monitoring, measurements and related performance indicators) needed to ensure the effective operation and control of these processes;
- d) determine the resources needed for these processes and ensure their availability;
- e) assign the responsibilities and authorities for these processes;
- f) address the risks and opportunities as determined in accordance with the requirements of [6.1](#);

- g) evaluate these processes and implement any changes needed to ensure that these processes achieve their intended results;
- h) improve the processes and the quality management system.

4.4.2 To the extent necessary, the organization shall:

- a) maintain documented information to support the operation of its processes;
- b) retain documented information to have confidence that the processes are being carried out as planned.

5 Leadership

5.1 Leadership and commitment

5.1.1 General

Top management shall demonstrate leadership and commitment with respect to the quality management system by:

- a) taking accountability for the effectiveness of the quality management system;
- b) ensuring that the quality policy and quality objectives are established for the quality management system and are compatible with the context and strategic direction of the organization;
- c) ensuring the integration of the quality management system requirements into the organization's business processes;
- d) promoting the use of the process approach and risk-based thinking;
- e) ensuring that the resources needed for the quality management system are available;
- f) communicating the importance of effective quality management and of conforming to the quality management system requirements;
- g) ensuring that the quality management system achieves its intended results;
- h) engaging, directing and supporting persons to contribute to the effectiveness of the quality management system;
- i) promoting improvement;
- j) supporting other relevant management roles to demonstrate their leadership as it applies to their areas of responsibility.

NOTE Reference to "business" in this International Standard can be interpreted broadly to mean those activities that are core to the purposes of the organization's existence, whether the organization is public, private, for profit or not for profit.

5.1.2 Customer focus

Top management shall demonstrate leadership and commitment with respect to customer focus by ensuring that:

- a) customer and applicable statutory and regulatory requirements are determined, understood and consistently met;

- b) the risks and opportunities that can affect conformity of products and services and the ability to enhance customer satisfaction are determined and addressed;
- c) the focus on enhancing customer satisfaction is maintained.

5.2 Policy

5.2.1 Establishing the quality policy

Top management shall establish, implement and maintain a quality policy that:

- a. is appropriate to the purpose and context of the organization and supports its strategic direction;
- b. provides a framework for setting quality objectives;
- c. includes a commitment to satisfy applicable requirements;
- d. includes a commitment to continual improvement of the quality management system.

5.2.2 Communicating the quality policy

The quality policy shall:

- a) be available and be maintained as documented information;
- b) be communicated, understood and applied within the organization;
- c) be available to relevant interested parties, as appropriate.

5.3 Organizational roles, responsibilities and authorities

Top management shall ensure that the responsibilities and authorities for relevant roles are assigned, communicated and understood within the organization.

Top management shall assign the responsibility and authority for:

- a) ensuring that the quality management system conforms to the requirements of this International Standard;
- b) ensuring that the processes are delivering their intended outputs;
- c) reporting on the performance of the quality management system and on opportunities for improvement (see [10.1](#)), in particular to top management;
- d) ensuring the promotion of customer focus throughout the organization;
- e) ensuring that the integrity of the quality management system is maintained when changes to the quality management system are planned and implemented.

6 Planning

6.1 Actions to address risks and opportunities

6.1.1 When planning for the quality management system, the organization shall consider the issues referred to in [4.1](#) and the requirements referred to in [4.2](#) and determine the risks and opportunities that need to be addressed to:

- a) give assurance that the quality management system can achieve its intended result(s);
- b) enhance desirable effects;
- c) prevent, or reduce, undesired effects;
- d) achieve improvement.

6.1.2 The organization shall plan:

- a) actions to address these risks and opportunities;

b) how to:

1. integrate and implement the actions into its quality management system processes (see [4.4](#));
2. evaluate the effectiveness of these actions.

Actions taken to address risks and opportunities shall be proportionate to the potential impact on the conformity of products and services.

NOTE 1 Options to address risks can include avoiding risk, taking risk in order to pursue an opportunity, eliminating the risk source, changing the likelihood or consequences, sharing the risk, or retaining risk by informed decision.

NOTE 2 Opportunities can lead to the adoption of new practices, launching new products, opening new markets, addressing new customers, building partnerships, using new technology and other desirable and viable possibilities to address the organization's or its customers' needs.

6.2 Quality objectives and planning to achieve them

6.2.1 The organization shall establish quality objectives at relevant functions, levels and processes needed for the quality management system.

The quality objectives shall:

- a) be consistent with the quality policy;
- b) be measurable;
- c) take into account applicable requirements;
- d) be relevant to conformity of products and services and to enhancement of customer satisfaction;
- e) be monitored;
- f) be communicated;
- g) be updated as appropriate.

The organization shall maintain documented information on the quality objectives.

6.2.2 When planning how to achieve its quality objectives, the organization shall determine:

- a. what will be done;
- b. what resources will be required;
- c. who will be responsible;
- d. when it will be completed;
- e. how the results will be evaluated.

6.3 Planning of changes

When the organization determines the need for changes to the quality management system, the changes shall be carried out in a planned manner (see [4.4](#)).

The organization shall consider:

- a. the purpose of the changes and their potential consequences;
- b. the integrity of the quality management system;
- c. the availability of resources;
- d. the allocation or reallocation of responsibilities and authorities.

7 Support

7.1 Resources

7.1.1 General

The organization shall determine and provide the resources needed for the establishment, implementation, maintenance and continual improvement of the quality management system.

The organization shall consider:

- a. the capabilities of, and constraints on, existing internal resources;
- b. what needs to be obtained from external providers.

7.1.2 People

The organization shall determine and provide the persons necessary for the effective implementation of its quality management system and for the operation and control of its processes.

7.1.3 Infrastructure

The organization shall determine, provide and maintain the infrastructure necessary for the operation of its processes and to achieve conformity of products and services.

NOTE Infrastructure can include:

- a. buildings and associated utilities;
- b. equipment, including hardware and software;
- c. transportation resources;
- d. information and communication technology.

7.1.4 Environment for the operation of processes

The organization shall determine, provide and maintain the environment necessary for the operation of its processes and to achieve conformity of products and services.

NOTE A suitable environment can be a combination of human and physical factors, such as:

- a. social (e.g. non-discriminatory, calm, non-confrontational);
- b. psychological (e.g. stress-reducing, burnout prevention, emotionally protective);
- c. physical (e.g. temperature, heat, humidity, light, airflow, hygiene, noise).

These factors can differ substantially depending on the products and services provided.

7.1.5 Monitoring and measuring resources

7.1.5.1 General

The organization shall determine and provide the resources needed to ensure valid and reliable results when monitoring or measuring is used to verify the conformity of products and services to requirements.

The organization shall ensure that the resources provided:

- a. are suitable for the specific type of monitoring and measurement activities being undertaken;
- b. are maintained to ensure their continuing fitness for their purpose.

The organization shall retain appropriate documented information as evidence of fitness for purpose of the monitoring and measurement resources.

7.1.5.2 Measurement traceability

When measurement traceability is a requirement, or is considered by the organization to be an essential part of providing confidence in the validity of measurement results, measuring equipment shall be:

- a. calibrated or verified, or both, at specified intervals, or prior to use, against measurement standards traceable to international or national measurement standards; when no such standards exist, the basis used for calibration or verification shall be retained as documented information;
- b. identified in order to determine their status;
- d) safeguarded from adjustments, damage or deterioration that would invalidate the calibration status and subsequent measurement results.

The organization shall determine if the validity of previous measurement results has been adversely affected when measuring equipment is found to be unfit for its intended purpose, and shall take appropriate action as necessary.

7.1.6 Organizational knowledge

The organization shall determine the knowledge necessary for the operation of its processes and to achieve conformity of products and services.

This knowledge shall be maintained and be made available to the extent necessary.

When addressing changing needs and trends, the organization shall consider its current knowledge and determine how to acquire or access any necessary additional knowledge and required updates.

NOTE 1 Organizational knowledge is knowledge specific to the organization; it is generally gained by experience. It is information that is used and shared to achieve the organization's objectives.

NOTE 2 Organizational knowledge can be based on:

- a) Internal sources (e.g. intellectual property; knowledge gained from experience; lessons learned from failures and successful projects; capturing and sharing undocumented knowledge and experience; the results of improvements in processes, products and services);
- b) External sources (e.g. standards; academia; conferences; gathering knowledge from customers or external providers).

7.2 Competence

The organization shall:

- a) determine the necessary competence of person(s) doing work under its control that affects the performance and effectiveness of the quality management system;
- b) ensure that these persons are competent on the basis of appropriate education, training, or experience;
- c) where applicable, take actions to acquire the necessary competence, and evaluate the effectiveness of the actions taken;
- d) retain appropriate documented information as evidence of competence.

NOTE Applicable actions can include, for example, the provision of training to, the mentoring of, or the re-assignment of currently employed persons; or the hiring or contracting of competent persons.

7.3 Awareness

The organization shall ensure that persons doing work under the organization's control are aware of:

- a) the quality policy;
- b) relevant quality objectives;
- c) their contribution to the effectiveness of the quality management system, including the benefits of improved performance;
- d) the implications of not conforming with the quality management system requirements.

7.4 Communication

The organization shall determine the internal and external communications relevant to the quality management system, including:

- a) on what it will communicate;
- b) when to communicate;
- c) with whom to communicate;
- d) how to communicate;
- e) who communicates.

7.5 Documented information

7.5.1 General

The organization's quality management system shall include:

- a) documented information required by this International Standard;
- b) documented information determined by the organization as being necessary for the effectiveness of the quality management system.

NOTE The extent of documented information for a quality management system can differ from one organization to another due to:

- the size of organization and its type of activities, processes, products and services;
- the complexity of processes and their interactions;
- the competence of persons.

7.5.2 Creating and updating

When creating and updating documented information, the organization shall ensure appropriate:

- a. identification and description (e.g. a title, date, author, or reference number);
- b. format (e.g. language, software version, graphics) and media (e.g. paper, electronic);
- c. review and approval for suitability and adequacy.

7.5.3 Control of documented information

7.5.3.1 Documented information required by the quality management system and by this International Standard shall be controlled to ensure:

- a. it is available and suitable for use, where and when it is needed;
- b. it is adequately protected (e.g. from loss of confidentiality, improper use, or loss of integrity).

7.5.3.2 For the control of documented information, the organization shall address the following activities, as applicable:

- a. distribution, access, retrieval and use;
- b. storage and preservation, including preservation of legibility;
- c. control of changes (e.g. version control);
- d. retention and disposition.

Documented information of external origin determined by the organization to be necessary for the planning and operation of the quality management system shall be identified as appropriate, and be controlled.

Documented information retained as evidence of conformity shall be protected from unintended alterations.

NOTE Access can imply a decision regarding the permission to view the documented information only, or the permission and authority to view and change the documented information.

8 Operation

8.1 Operational planning and control

The organization shall plan, implement and control the processes (see [4.4](#)) needed to meet the requirements for the provision of products and services, and to implement the actions determined in [Clause 6](#), by:

- a) determining the requirements for the products and services;
- b) establishing criteria for:
 - 1) the processes;
 - 2) the acceptance of products and services;
- c) determining the resources needed to achieve conformity to the product and service requirements;
- d) implementing control of the processes in accordance with the criteria;

- e) determining, maintaining and retaining documented information to the extent necessary:
 - to have confidence that the processes have been carried out as planned;
 - to demonstrate the conformity of products and services to their requirements.

The output of this planning shall be suitable for the organization's operations.

The organization shall control planned changes and review the consequences of unintended changes, taking action to mitigate any adverse effects, as necessary.

The organization shall ensure that outsourced processes are controlled (see [8.4](#)).

8.2 Requirements for products and services

8.2.1 Customer communication

Communication with customers shall include:

- a) providing information relating to products and services;
- b) handling enquiries, contracts or orders, including changes;
- c) obtaining customer feedback relating to products and services, including customer complaints;
- d) handling or controlling customer property;
- e) establishing specific requirements for contingency actions, when relevant.

8.2.2 Determining the requirements for products and services

When determining the requirements for the products and services to be offered to customers, the organization shall ensure that:

- a) the requirements for the products and services are defined, including:
 - any applicable statutory and regulatory requirements;
 - those considered necessary by the organization;
- b) the organization can meet the claims for the products and services it offers.

8.2.3 Review of the requirements for products and services

8.2.3.1 The organization shall ensure that it has the ability to meet the requirements for products and services to be offered to customers. The organization shall conduct a review before committing to supply products and services to a customer, to include:

- a) requirements specified by the customer, including the requirements for delivery and post-delivery activities;
- b) requirements not stated by the customer, but necessary for the specified or intended use, when known;
- c) requirements specified by the organization;
- d) statutory and regulatory requirements applicable to the products and services;
- e) contract or order requirements differing from those previously expressed.

The organization shall ensure that contract or order requirements differing from those previously defined are resolved.

The customer's requirements shall be confirmed by the organization before acceptance, when the customer does not provide a documented statement of their requirements.

NOTE In some situations, such as internet sales, a formal review is impractical for each order. Instead, the review can cover relevant product information, such as catalogues.

8.2.3.2 The organization shall retain documented information, as applicable:

- a. on the results of the review;
- b. on any new requirements for the products and services.

8.2.4 Changes to requirements for products and services

The organization shall ensure that relevant documented information is amended, and that relevant persons are made aware of the changed requirements, when the requirements for products and services are changed.

8.3 Design and development of products and services

8.3.1 General

The organization shall establish, implement and maintain a design and development process that is appropriate to ensure the subsequent provision of products and services.

8.3.2 Design and development planning

In determining the stages and controls for design and development, the organization shall consider:

- a. the nature, duration and complexity of the design and development activities;
- b. the required process stages, including applicable design and development reviews;
- c. the required design and development verification and validation activities;
- d. the responsibilities and authorities involved in the design and development process;
- e. the internal and external resource needs for the design and development of products and services;
- f. the need to control interfaces between persons involved in the design and development process;
- g. the need for involvement of customers and users in the design and development process;
- h. the requirements for subsequent provision of products and services;
- i. the level of control expected for the design and development process by customers and other relevant interested parties;
- j. the documented information needed to demonstrate that design and development requirements have been met.

8.3.3 Design and development inputs

The organization shall determine the requirements essential for the specific types of products and services to be designed and developed. The organization shall consider:

- a) functional and performance requirements;
- b) information derived from previous similar design and development activities;
- c) statutory and regulatory requirements;
- d) standards or codes of practice that the organization has committed to implement;
- e) potential consequences of failure due to the nature of the products and services. Inputs shall be adequate for design and development purposes, complete and unambiguous.

Conflicting design and development inputs shall be resolved.

The organization shall retain documented information on design and development inputs.

8.3.4 Design and development controls

The organization shall apply controls to the design and development process to ensure that:

- a. the results to be achieved are defined;
- b. reviews are conducted to evaluate the ability of the results of design and development to meet requirements;
- c. verification activities are conducted to ensure that the design and development outputs meet the input requirements;
- d. validation activities are conducted to ensure that the resulting products and services meet the requirements for the specified application or intended use;
- e. any necessary actions are taken on problems determined during the reviews, or verification and validation activities;
- f. documented information of these activities is retained.

NOTE Design and development reviews, verification and validation have distinct purposes. They can be conducted separately or in any combination, as is suitable for the products and services of the organization.

8.3.5 Design and development outputs

The organization shall ensure that design and development outputs:

- a. meet the input requirements;
- b. are adequate for the subsequent processes for the provision of products and services;
- c. include or reference monitoring and measuring requirements, as appropriate, and acceptance criteria;
- d. specify the characteristics of the products and services that are essential for their intended purpose and their safe and proper provision.

The organization shall retain documented information on design and development outputs.

8.3.6 Design and development changes

The organization shall identify, review and control changes made during, or subsequent to, the design and development of products and services, to the extent necessary to ensure that there is no adverse impact on conformity to requirements.

The organization shall retain documented information on:

- a. design and development changes;
- b. the results of reviews;
- c. the authorization of the changes;
- d. the actions taken to prevent adverse impacts.

8.4 Control of externally provided processes, products and services

8.4.1 General

The organization shall ensure that externally provided processes, products and services conform to requirements.

The organization shall determine the controls to be applied to externally provided processes, products and services when:

- a. products and services from external providers are intended for incorporation into the organization's own products and services;
- b. products and services are provided directly to the customer(s) by external providers on behalf of the organization;
- c. a process, or part of a process, is provided by an external provider as a result of a decision by the organization.

The organization shall determine and apply criteria for the evaluation, selection, monitoring of performance, and re-evaluation of external providers, based on their ability to provide processes or products and services in accordance with requirements. The organization shall retain documented information of these activities and any necessary actions arising from the evaluations.

8.4.2 Type and extent of control

The organization shall ensure that externally provided processes, products and services do not adversely affect the organization's ability to consistently deliver conforming products and services to its customers.

The organization shall:

- a. ensure that externally provided processes remain within the control of its quality management system;
- b. define both the controls that it intends to apply to an external provider and those it intends to apply to the resulting output;
- c. take into consideration:
 - the potential impact of the externally provided processes, products and services on the organization's ability to consistently meet customer and applicable statutory and regulatory requirements;
 - the effectiveness of the controls applied by the external provider;
- d. determine the verification, or other activities, necessary to ensure that the externally provided processes, products and services meet requirements.

8.4.3 Information for external providers

The organization shall ensure the adequacy of requirements prior to their communication to the external provider.

The organization shall communicate to external providers its requirements for:

- a. the processes, products and services to be provided;
- b. the approval of:
 - products and services;
 - methods, processes and equipment;
 - the release of products and services;
- c. competence, including any required qualification of persons;
- d. the external providers' interactions with the organization;
- e. control and monitoring of the external providers' performance to be applied by the organization;
- f. verification or validation activities that the organization, or its customer, intends to perform at the external providers' premises.

8.5 Production and service provision

8.5.1 Control of production and service provision

The organization shall implement production and service provision under controlled conditions.

Controlled conditions shall include, as applicable:

- a. the availability of documented information that defines:
 1. the characteristics of the products to be produced, the services to be provided, or the activities to be performed;
 2. the results to be achieved;
- b. the availability and use of suitable monitoring and measuring resources;
- c. the implementation of monitoring and measurement activities at appropriate stages to verify that criteria for control of processes or outputs, and acceptance criteria for products and services, have been met;
- d. the use of suitable infrastructure and environment for the operation of processes;
- e. the appointment of competent persons, including any required qualification;
- f. the validation, and periodic revalidation, of the ability to achieve planned results of the processes for production and service provision, where the resulting output cannot be verified by subsequent monitoring or measurement;
- g. the implementation of actions to prevent human error;
- h. the implementation of release, delivery and post-delivery activities.

8.5.2 Identification and traceability

The organization shall use suitable means to identify outputs when it is necessary to ensure the conformity of products and services.

The organization shall identify the status of outputs with respect to monitoring and measurement requirements throughout production and service provision.

The organization shall control the unique identification of the outputs when traceability is a requirement, and shall retain the documented information necessary to enable traceability.

8.5.3 Property belonging to customers or external providers

The organization shall exercise care with property belonging to customers or external providers while it is under the organization's control or being used by the organization.

The organization shall identify, verify, protect and safeguard customers' or external providers' property provided for use or incorporation into the products and services.

When the property of a customer or external provider is lost, damaged or otherwise found to be unsuitable for use, the organization shall report this to the customer or external provider and retain documented information on what has occurred.

NOTE A customer's or external provider's property can include materials, components, tools and equipment, premises, intellectual property and personal data.

8.5.4 Preservation

The organization shall preserve the outputs during production and service provision, to the extent necessary to ensure conformity to requirements.

NOTE Preservation can include identification, handling, contamination control, packaging, storage, transmission or transportation, and protection.

8.5.5 Post-delivery activities

The organization shall meet requirements for post-delivery activities associated with the products and services.

In determining the extent of post-delivery activities that are required, the organization shall consider:

- a. statutory and regulatory requirements;
- b. the potential undesired consequences associated with its products and services;
- c. the nature, use and intended lifetime of its products and services;
- d. customer requirements;
- e. customer feedback.

NOTE Post-delivery activities can include actions under warranty provisions, contractual obligations such as maintenance services, and supplementary services such as recycling or final disposal.

8.5.6 Control of changes

The organization shall review and control changes for production or service provision, to the extent necessary to ensure continuing conformity with requirements.

The organization shall retain documented information describing the results of the review of changes, the person(s) authorizing the change, and any necessary actions arising from the review.

8.6 Release of products and services

The organization shall implement planned arrangements, at appropriate stages, to verify that the product and service requirements have been met.

The release of products and services to the customer shall not proceed until the planned arrangements have been satisfactorily completed, unless otherwise approved by a relevant authority and, as applicable, by the customer.

The organization shall retain documented information on the release of products and services. The documented information shall include:

- a. evidence of conformity with the acceptance criteria;
- b. traceability to the person(s) authorizing the release.

8.7 Control of nonconforming outputs

8.7.1 The organization shall ensure that outputs that do not conform to their requirements are identified and controlled to prevent their unintended use or delivery.

The organization shall take appropriate action based on the nature of the nonconformity and its effect on the conformity of products and services. This shall also apply to

nonconforming products and services detected after delivery of products, during or after the provision of services.

The organization shall deal with nonconforming outputs in one or more of the following ways:

- a. correction;
- b. segregation, containment, return or suspension of provision of products and services;
- c. informing the customer;
- d. obtaining authorization for acceptance under concession.

Conformity to the requirements shall be verified when nonconforming outputs are corrected.

8.7.2 The organization shall retain documented information that:

- a. describes the nonconformity;
- b. describes the actions taken;
- c. describes any concessions obtained;
- d. identifies the authority deciding the action in respect of the nonconformity.

9 Performance evaluation

9.1 Monitoring, measurement, analysis and evaluation

9.1.1 General

The organization shall determine:

- a. what needs to be monitored and measured;
- b. the methods for monitoring, measurement, analysis and evaluation needed to ensure valid results;
- c. when the monitoring and measuring shall be performed;
- d. when the results from monitoring and measurement shall be analysed and evaluated.

The organization shall evaluate the performance and the effectiveness of the quality management system.

The organization shall retain appropriate documented information as evidence of the results.

9.1.2 Customer satisfaction

The organization shall monitor customers' perceptions of the degree to which their needs and expectations have been fulfilled. The organization shall determine the methods for obtaining, monitoring and reviewing this information.

NOTE Examples of monitoring customer perceptions can include customer surveys, customer feedback on delivered products and services, meetings with customers, market-share analysis, compliments, warranty claims and dealer reports.

9.1.3 Analysis and evaluation

The organization shall analyse and evaluate appropriate data and information arising from monitoring and measurement.

The results of analysis shall be used to evaluate:

- a. conformity of products and services;
- b. the degree of customer satisfaction;
- c. the performance and effectiveness of the quality management system;
- d. if planning has been implemented effectively;
- e. the effectiveness of actions taken to address risks and opportunities;
- f. the performance of external providers;
- g. the need for improvements to the quality management system.

NOTE Methods to analyse data can include statistical techniques.

9.2 Internal audit

9.2.1 The organization shall conduct internal audits at planned intervals to provide information on whether the quality management system:

- a. conforms to:
 - the organization's own requirements for its quality management system;
 - the requirements of this International Standard;
- b. is effectively implemented and maintained.

9.2.2 The organization shall:

- a. plan, establish, implement and maintain an audit programme(s) including the frequency, methods, responsibilities, planning requirements and reporting, which shall take into consideration the importance of the processes concerned, changes affecting the organization, and the results of previous audits;
- b. define the audit criteria and scope for each audit;
- c. select auditors and conduct audits to ensure objectivity and the impartiality of the audit process;
- d. ensure that the results of the audits are reported to relevant management;
- e. take appropriate correction and corrective actions without undue delay;
- f. retain documented information as evidence of the implementation of the audit programme and the audit results.

NOTE See ISO 19011 for guidance.

9.3 Management review

9.3.1 General

Top management shall review the organization's quality management system, at planned intervals, to ensure its continuing suitability, adequacy, effectiveness and alignment with the strategic direction of the organization.

9.3.2 Management review inputs

The management review shall be planned and carried out taking into consideration:

- a. the status of actions from previous management reviews;
- b. changes in external and internal issues that are relevant to the quality management system;
- c. information on the performance and effectiveness of the quality management system, including trends in:
 1. customer satisfaction and feedback from relevant interested parties;

2. the extent to which quality objectives have been met;
 3. process performance and conformity of products and services;
 4. nonconformities and corrective actions;
 5. monitoring and measurement results;
 6. audit results;
 7. the performance of external providers;
- d. the adequacy of resources;
 - e. the effectiveness of actions taken to address risks and opportunities (see [6.1](#));
 - f. opportunities for improvement.

9.3.3 Management review outputs

The outputs of the management review shall include decisions and actions related to:

- a. opportunities for improvement;
- b. any need for changes to the quality management system;
- c. resource needs.

The organization shall retain documented information as evidence of the results of management reviews.

10 Improvement

10.1 General

The organization shall determine and select opportunities for improvement and implement any necessary actions to meet customer requirements and enhance customer satisfaction.

These shall include:

- a. improving products and services to meet requirements as well as to address future needs and expectations;
- b. correcting, preventing or reducing undesired effects;
- c. improving the performance and effectiveness of the quality management system.

NOTE Examples of improvement can include correction, corrective action, continual improvement, breakthrough change, innovation and re-organization.

10.2 Nonconformity and corrective action

10.2.1 When nonconformity occurs, including any arising from complaints, the organization shall:

- a. react to the nonconformity and, as applicable:
 1. take action to control and correct it;
 2. deal with the consequences;
- b. evaluate the need for action to eliminate the cause(s) of the nonconformity, in order that it does not recur or occur elsewhere, by:
 1. reviewing and analyzing the nonconformity;
 2. determining the causes of the nonconformity;
 3. determining if similar nonconformities exist, or could potentially occur;
- c. implement any action needed;

- d. review the effectiveness of any corrective action taken;
- e. update risks and opportunities determined during planning, if necessary;
- f. make changes to the quality management system, if necessary.

Corrective actions shall be appropriate to the effects of the nonconformities encountered.

10.2.2 The organization shall retain documented information as evidence of:

- a. the nature of the nonconformities and any subsequent actions taken;
- b. the results of any corrective action.

10.3 Continual improvement

The organization shall continually improve the suitability, adequacy and effectiveness of the quality management system.

The organization shall consider the results of analysis and evaluation, and the outputs from management review, to determine if there are needs or opportunities that shall be addressed as part of continual improvement.