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"ENGINEERING PLANNING FOR INDUSTRIAL DEVELOPMENT IN PAKISTAN"

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I. Introduction :—

The diminishing trends in export of raw materials will be an index about their utilisation within our country and a yard stick to measure our industrial development. We have already made an encouraging start in face of innumerable odds to build up various manufacturing concerns spread over the entire country both at government level and through individual enterprise. There is need at the moment to eradicate all possible handicaps which impede the way of healthy growth of the industry. Leaving aside problems like the procurement of foreign machinery where we may not have much say in cutting down the delivery period delays there are some factors certainly within our control which go a long away in achieving our objective. Proper engineering planning in putting up of our factories is a major contribution to overcome not only a number of bottle-necks at preliminary stages but also for efficient running of the manufacturing process at all times to come. This factor has unfortunately not been given its due importance by our industrialists and in most of the cases it was too late in the day to redeem their omissions. In their zeal to get things going and for lack of guidance most of the firms start off in too much of a hurry and a disorganised manner. An effort has been made in this paper to bring on record various important technical factors to be kept in view at different stages to set up well planned industrial organizations.

Scope :—

The role which building up of industry has to play in development of a raw material producing country like ours demands stock taking of various handicaps blocking the progress. Some of the problems facing this industrialistion are typical of our conditions in different parts of the country and quite different from the developed countries of the world. As a consequence we can best learn to improve based on our own experience. The past few years in history of our industrial development can surely teach us a lot. A capitalist or an organisation which is interested to set up an industrial enterprise should benefit from obstacles surmouned by others and this is only possible if a written account of such achievements and the enviroments under which they progress is forthcoming. The scope for shaping of the engineering planning to standardise the national requirements in the field is very wide indeed. This paper aims at recording some of the important engineering considerations which should be kept in mind at the correct stage of setting up of

an industrial concern. It is far from being complete in all respects and strives to draw attention of the authorities and private industrialists towards this important problem a solution of which will contribute towards continual efficiency of the manufacturing operations.

As a matter of fact each of the various items to which just a passing reference has been made in this text requires a detailed study and a specialised exposition, necessitating years of study and experience.

Various stages coming within the purview of engineering planning of a factory can be roughly classified as below :—

(1) Selection of site on general considerations.

(2) Collection of technical data for the preliminary economic appraisal.

(3) Engineering and resource survey of the site.

(4) Drafting the schedule of requirement for the main machinery and inviting the tenders.

(5) Securing services of a specialised engineer.

(6) Detailed financial appraisal.

(7) Procurement of the best suited and economical machinery within the shortest period.

(8) Procurement of the secondary machinery if needed based on specifiations for the main machinary.

(9) Building planning to suit the machinery purchased.

(10) Fire insurance requirements.

(11) Provision of the water supply system.

(12) Insertion of the transport facilities like the railway siding and road lay out in the building planning and their construction prior to receipt of the machinery.

(13) Arranging postal and tele-communication facilities.

(14) Invitation to the building tenders.

(15) Synchronisation of the building execution with receipt of the machinery.

(16) Care of the machinery prior to erection.

(17) Construction planning.

(18) Erection of the machinery.

(19) Scope for future development and improvements

(20) Testing performance and output of the machinery as connected with construction of various building units.

Generally speaking time factor is of great importance in setting up any industrial project because of the quick turnover and increased dividends desirable on capital at charge. It is imperative therefore that proper

sequence of different steps to be taken at different stages should be fully known to the interested agencies. If any link of the planning undertaking is lost sight of at the opportune time it may be responsible for a serious setting back of the entire project. In other cases the omissions when made good subsequently may result in snags, bottle-necks and jarring effects in the scheme which will be eye sores in the finished project for all times to come. There is a general tendency to place a quick order for the machinary without listing the exact requirement. Right use of the time which lapses after that is not made by proceeding with the other activities and it is considered good enough to pend further action till after the machinery is received. The fact that complete machinery is not ordered in the first instance conributes to extensive delays and to that is added the precious time lost in not tackling the other issues like planning orientation of the factory units, fitting in the railway siding, road transport and arrangement for electricity if it is to be obtained from some hydel schemes etc. Invariably the importance of proceeding with different aspects of the proposal is ignored because the interested persons have got no idea on what lines to proceed.

(1) Selection of site.

General considerations :—The conditions governing the selection of site for different industries are extremely varying. Merit of each siting depends on the type of industry being set up. There may be a few broad principles which could be applied in general to cases more than one. There may be prohibitive clauses against setting up certain manufacruring processes in certain areas and thus cutting down the flexibility of the site selection. In most of the cases the considerations governing establishment of an industry are such as not to leave much of a choice for alternative sites. Sometimes a tendency is noticeable on part of promoters of a scheme to plan these concerns close to their native places irrespective of any considerations directly contributing to profitable development of the industry. The over-riding criterion for fixing the site should be based on the economical appraisal associated with a particular choice.

Certain industries like bone crushing, tanneries, sugar making, distilleries etc. have to be far removed from the town limits. Similarly there are a number of other processes giving rise to obnoxious odours and harmful gases affecting the health of the population at large which under hygienic bye-laws must be kept at a specified distance from the built up areas. It is imperative that while setting up any industry of this type these regulations should be kept in view. Sufficient provision should also be made for future expansions of towns or any schemes for building sattelite towns.

Precise site examination.

(*a*) *Economic appraisal.*—Economic evaluation for the cost of production should determine the merits of a particular site. There are industries like fertilizer plants which have to be located close to the raw material source because its volume is nearly 3 times the volume of the finished product. On the other hand there are industries which have to cater for the close distribution of finished products to fix their sites. It is necessary to judge at what cost the finished products from a particular location of the factory will be available in the market at different centres of demand and what will be the comparative value. This will tentatively fix the site best suited from the point of view of the costing of the operation.

(*b*) *Adequacy of the area.*—The rough proposal for the factory lay out and different residential colonies should fit in the plot of land in view. Ample provision for future extensions should also be made. A choice between alternative sites is possible only after a bit more detailed examination has been carried out of the characteristics other than the apparent qualities such as location with respect to a town, transport facilities, navigation facilities, nearness to a river or a perennial stream. In certain cases study of even only the visible points may enable selection out of the different alternatives.

(*c*) *Investigation of the site.*—Before design work for fixing the details of buildings is taken in hand it is necessary that full investigations regarding the subsoil conditions should be made. After doing a rough planning it should be decided at what approximate points different units of the lay out are going to fall. Then sites for trial pits should be marked with their distances apart as determined by importance of the structure and visible signs of variatian in the ground strata.

The system of digging these pits and their depth is decided by nature of the soil encountered and by the rough idea of the pressure to be distributed to the foundations. Execpt in case of very deep made up earth or where foundations must be taken to rock or where subsoil water depth must be determined there is hardly an occasion to resort to machine trial boring. Whether ordinary digging or rig drillidg is done it is better if positive strata samples are taken rather than indirect conclusions based on water circulation washings as in a rotary machine which is a specialised job.

Sometimes the soil may be so much running that shoring may have to be done to take ordinary open pits to the required depths. The frequency of the pits should be so decided that different lay out of the strata are truly represented and no deceptive formations remain unexplored.

In the case of very big projects and important buildings load tests of soil should be conducted at site to determine their bearing pressures and time settlement curves rather than guessing these values arbitrarily from other known soil characteristics.

During the course of soil investigations the following factors should be kept in view :—

(*d*) *Sub-surface study.*

(*i*) Lay out of the possible soft strata below seemingly hard formations should be fully explored.

(*ii*) Old foundations, and buried structures should be located.

(*iii*) Variations in continuity of strata like loam clay and sand belts should be properly investigated throughout under the site of the proposed important structures so as to adopt remedial measures against uneven settlement.

(*iv*) In case of shallow depth rocks possibility of any ravines filled up with boulders should be examined.

(*v*) It should be examined whether water table is not high and if so special precautions for water proofing the basement will have to be taken.

(*vi*) In the case of pile foundations determination of water table is very important. Variations in the water table spread over different seasons should be estimated and also approximate water pressure encountered which will fix upward pressure against which the basement must be made strong enough.

(*vii*) Subsoil study should also be made with a view to determine suitabillity of the soil for brick moulding. Prior instructions from the test laboratory from where advice is to be sought should be available for guidance to take the samples.

Surface study.—

(*i*) Flow of any ravines in the site should be determined.

(*ii*) Topographic features of the site should be studied especially to see whether it is prone to flooding.

(*iii*) Formation of drifting sand dunes in the site should be seen.

(*iv*) Effect of saltpeter and dampness in the area if any should be known.

(*v*) Direction of prevailing winds and their intensity in different parts of the year should be determined.

(*vi*) Lay out of any adjoining buildings, mountain ranges and forest growth which will affect the intensity of natural lighting of the main factory building should be marked.

(*vii*) Application of the building codes and any other local regulations checking free choice of the building design, lay out and area utilisation should be fully known.

(*e*) *Application of the soil study* :—

(*i*) Various characteristics of the soil as examined above will enable an industrialist to frame an idea about the type of foundations he is to follow. If the soil is poor and yielding he may have to either adopt long spanned load transmission points or to follow raft foundations monolithic with the superstructure. In certain other cases stepped foundations may have to be followed.

(*ii*) If uneven settlement of superstructure is expected it should be provided for in design of the foundations in case no material alteration in type of the superstructure is possible.

(*iii*) Type of building material to be employed may be determined by the nature of soil. If it is yielding and unstable rigid concrete or brick construction may have to be ruled out for danger of crack development. Sometimes brick masonry construction with liberal provision of stress relieving joints is followed. However it is preferable to follow the more elastic steel framed superstructure in such cases.

(*iv*) If the soil is poor the design of continuous trusses beams and girders which may be economical may not perhaps be suitable because of very heavy loads which will be transmitted to the subgrade.

(*v*) If an uneven settlement cannot be remedied economically by adopting a particular design of foundations then construction of the superstructure will have to be adjusted to stand it efficiently.

(*vi*) Sometimes ; keeping in view the unsuitable foundation conditions it is considered more advantageous to build up multistorey buildings.

(*f*) *Site development*.—Some of the sites which have great variation in the levels will require proper grading and development prior to building up. It may be considered to construct the main factory units on a levelled out plot giving due consideration to the permissible grades of railway tracks and roads. The other residential buildings may be built on terrace formation involving minimum cutting or filling of the terrain.

(g) *Comparison of alternative sites.*—The cost of land should be added to the cost for foundations and development as based on the detailed soil study of a particular site. It is probable that selection of an alternative bigger plot of land or land better situated may be possible at the same cost after comparing what construction of foundations and proper grading is going to cost in all cases and their possible influence on the design of the superstructure.

(2) Engineering Survey :—

After it is settled to go in for a particular site it is necessary to conduct its detailed survey on the following lines for preparation of the key plan and the index plan :—

(a) Detailed levelling should be done with a view to prepare a contoured plan of the site.

(b) Plane tabling should be carried out to mark importantt opographic features of the place such as enumerated below :—

(i) Boundary line and position of important adjoining structures.

(ii) Public roads, rights of easement from the adjoining plots into the site or from the latter required into the former.

(iii) Existing structures in the land.

(iv) Position of the transport facilities such as roads, railway lines or canals, rivers, etc., for navigation, showing representative levels during their course at different points.

(v) Position of the nearest railway station showing signals, goods sidings and merchants plots in the yard if it is within a reasonable distance and can possibly be shown on the index plan.

(vi) Important bridges under different transport systems in the vicinity.

(vii) Rivers, streams, canals, ravines with levels of some firm points on their banks and average depth of water variation in different seasons.

(viii) Quarries and sources of other building materials.

(ix) Nearest sources of potable water supply such as tube wells shallow wells and position of water supply pipe line if passing anywhere close to the site. Strata cross sections of these wells should also be detailed.

(x) Position of electric traction lines from thermal plants or from some hydro-electric scheme. Foundation details of the traction poles. towers etc., if passing through the site and required to be shifted outside the boundary limits.

(*xi*) Population settlements within a reasonable distance from the site to study influence of the drainage and trade waste disposal on them.

(*xii*) Location of the site where soil has been tested to be suitable for burning bricks. The index plan should also show direction of wind during different parts of the year and the north line. If there are extensive level variations or any other salient geological features of the area surrounding the site under examination these particulars should also be picked up.

(3) Water supply trials :—

It is needlees to stress that availability of good quality water both for mill processing and for domestic use is a pre-requisite for selection of a site. Information from the close by localities about type of water available will give a rough indication weather the site will yield dependable quality and quantity of water. Some people attach so much importance to the problem of water supply for the particular plot (ignoring information of the water survey from the surroundings) that they would like to drill a trial boring as one of the preliminary steps to test suitability of the site. The depth of such a bore should be taken to the level to which it is proposed to sink the main tube well. For determining this depth and to be prepared to encounter different types of strata it will be very much helpful if cross sections of other tube wells existing in the close vicinity are obtained and also the geological map of the locality.

Water analysis from different depths of the aquifer must be got done from a reputable test laboratory or a chemist who is well acquainted with this type of work. Before sending the water samples it is necessary to get an expert opinion on the desirable composition and maximum limits of different chemical radicals allowable for a particular processing so that the analyst is rightly guided on what lines to proceed. In case it is decided to stick to a site for other strong reasons even if the water quality is not up to the mark treatment with water softening plants or other reduction processes will have to be investigated based on the particular analysis results.

It is desirable to utilise even the trial bore for pumping out water and not to spend money purely for trial purposes. For selecting site of such a trial bore it is better if the preliminary requirement of water for moulding of bricks and construction etc., is kept in view. One of the considerations for selecting size of the trial bore (the main of which will be the type of strata being drilled through) should be the demand of water for these initial requirements. For most of the sites in alluvial plains 6" dia. size will be enough but for submountaneus regions such as Jhelum and northwards in West Pakistan 8" size should be the minimum.



Considerable amount of monev has been spent on this textile mill without knowing whether good quality of water will be available at all or not. Thousands of rupees have been spent to transport water from a great distance to the mill site for building purposes. There are no signs of the tube well being completed as yet.

Time factor is of great value in the preliminary stages for the building activity in particular. The trial boring operation should be started sufficiently in advance particularly if it is decided to get it done by hand drilling operation which on average may take any time from one month to two months through easy soils. It is strongly recommended however that such like trials in the areas with difficult strata containing sticky clay or hard clay with shingle, conglomerate and loose boulder formations as encountered in Baluchistan, N. W. F. P., Jhelum, Rawalpindi and Attock Districts of the Punjab must be cartied out with percussion type drilling machines.

III. Financial Appraisal :

1. It is just a beginning of the industralisation development in the country and the question of local competition hardly arises. However for such time that home production is not enough to meet the total demand, import of foreign products cannot be checked even under the tariff commission protection. This is the critical stage for the nascent industrial enterprise and Pakistani stuff has to enter the market in keen competition with the foreign products. The financial appraisal is therefore most essential to determine the production costs not only for the current period but also for certain years to come. It will assist in planning to keep this figure as much low as possible and to have a better hold in the market than imported items. Cost benefit relations and amortization value of the project must be established.

2. Strictly speaking financial appraisal of an industrial project may not come in the orbit of engineering planning. However in any economic study for calculating the cost of production at a given location a lot of data has to be supplied by an engineer. It will not be out of place, therefore, to mention some points regarding this aspect :—

(*a*) *Selection of the site* :—Cost of land, utilisation of existing facilities such as reduction in building the laboure quarters owing to the closeby villages, canal water supply for general purposes, existing sewage system for proper drainage and waste disposal, availability of hydro-electric power close by and many other similar considerations will result in reduction of the overall cost of construction.

Certain industries demand development colonies for improving quality of raw material to be processed. For example wool industry requires sheep breeding farms and sugar industry needs land for cane. Sometimes selection of the main site for the factory itself may be influenced by price of the auxiliary site for giving an impetus to production.

(*b*) *Size of the factory* :—The size of the factory will naturally depend on the capacity of the machines to be installed. A certain unit which should be most economical from different

considerations should be selected to determine the scale of production. This will fix the other problems such as size of the factory, and the machinery to be ordered keeping the future expansion of course in view. If supply of any raw materials is seasonal this fact should be given due importance in fixing the size of the plant. This will enable estimation for construction of the factory building.

(*c*) *Cost of the machinery* :—Rough estimate of the cost of the machinery can be based depending upon the make selected, period during which the deed will be finalised and the cost of erection. The problem of availability of foreign exchange may have an important say in the selection of a particular make. If for the purposes of the appraisal some quotations are obtained from the manufacturer's agents the time factor for planning of the project to finish, trend of cost of engineering materials in the foreign markets and the basis of quotation whether F. O. B. some foreign port, C. I. F. Karachi or F. O. R. Karachi should all be kept in view.

(*d*) Residential quarters, offices, welfare and public buildings, water supply services, railway siding and transportation system should all be represented in the estimate. If there are any engineering requirements specially demanded by an industry they should also be covered in the appraisal.

(*e*) The by-products expected out of an industry and any additional cost required to render them worth presentation in the market should also be borne by the engineering portion of the estimate.

IV. Procurement of machinery :—

Before taking any steps for purchasing the machinery it is essential that detailed requirements should be known. Negotiations for heavy machinery take a considerable time before being finally settled and this delay will become all the more embarassing if care is not taken to draft a correct and complete demand. Besides the question of delay as a result of clarification which will ensue on an improper requisition there may be instances where wrong machinery or bigger capacity plant may be supplied resulting in wastage of large sums of money.

It should be appreciated that any delay in final working of a concern may mean locking up of considerable capital without its useful operation to earn any dividends. Moreover prices of the machinery may go up during this period. If the price index of different types of machinery is studied for the last few years it will be observed that but for a short period of downward trends general tendency of the price curve has been upwards. Appendix No. 1 exhibits a graph showing such a price fluctuation for some of the American machinery which was not affected

by the currency devaluation as in U. K. and also shows price fluctuation of machinery in Switzerland.

Scrutiny of offers :—

Every possible effort should be made to secure as many quotations on the schedule of requirement circulated as possible. For this purpose it is necessary to know addresses of all possible agencies of repute connected with different foreign countries specialising in manufacture of a particular machinery. To cut down this period of negotiation it is desirable that manufacturers should be asked to supply the questionnaire forms according to which they want information about the requirement. The answers should be supplied to them in addition to the specifications of machinery, raw material and detail of the processes as prepared by the indentor himself. Considering the question of the delivery period and certain other controlling factors such as the availability of foreign exchange it is very seldom that ample choice exists to pick and choose from a large number of offers. However if such a scope is possible great care should be exercised to sift out the best possible offer.

(*a*) The offers should be compared in detail with the Schedule of requirement point by point.

(*b*) Price of all the offers should be on the same basis, preferably F. O. R. Karachi.

(*c*) The efficiency of the machines offered, quality of raw material used for their construction, power and fuel consumption, complete range of accessories, spares and any special advantages of each should be considered in full detail.

(*d*) Delivery period may be the deciding factor in certain cases and sometimes price inequalities may have to be ignored in favour of very attractive period of supply.

(*e*) If there are any other facilities such as free assistance in planning of the factory building, preparation of drawings and erection of the machinery offered in the event of accepting a particular make they deserve consideration. These things should be clarified during the negotiation stage and every offer must touch these salient facilities which may count a lot in selecting a particular quotation.

(*f*) Another point of special consideration is about facility for supply of spares, maintenance and servicing of a particular brand of machinery in Pakistan.

(*g*) Certain machines demand construction of fixed type of buildings. Their foundations may be of an intricate nature. Their installation may impose a rigidity on the processing lay out. Treatment of industrial wastes may demand special processes and special disposal structures. Cost of

buildings and structures to suit lay outs of different type of machines should be calculated, added to machinery quotation and then their total cost so evaluated compared with one another.

Drafting the Acceptance of Tender :—

After selecting the best offer the acceptance of tender declaration should be carfully written out. It should contain the following general provisions :—

(*a*) Name and address of the suppliers and their agents in Pakistan.

(*b*) Reference to their quotation on which acceptance is being decided.

(*c*) Details of the machinery, accessories, erection tools accepted with their rated efficiency and output etc., if specified.

(*d*) Cost and system of payment generally 80% on shipping after preliminary inspection at works and 20% after erection and successful operation at site.

(*e*) *System of inspection :*—Authority of inspection should be mentioned and also the place of inspection.

(*f*) *Delivery Period :*—Ex-works and in Pakistan.

(*g*) Specifications of the raw material out of which machinery is to be manufactured and supply of maker's test certificates.

(*h*) *Drawings to be supplied by the Manufacturers :—*

(*i*) Lay out drawings for the machinery.

(*ii*) Foundation drawings.

(*iii*) Suggestion for the factory building to house the machinery.

(*iv*) Opinion about the lay out planning according to experience of the country of manufacture of the machinery.

(*v*) Flow drawings for the process working.

(*i*) *Documents to be supplied :*—(*i*) Detailed packing lists to be sent in advance with the shipping documents for checking up the machinery when it reaches the destination.

(*ii*) Instructions for erection of each of different machines. Maintenance handbooks and advice about the grade and type of fuel oil, lubrication oil etc.

(*iii*) Analysis sheet of the type of water best suited for this processing.

(*iv*) Consumption sheets for steam, electric power, water with their particulars etc.

(*j*) *Consignee* :—Correct name, address of the consignee and place of destination with the nearest railway station should be clearly mentioned.

(*k*) *Replacement of defective parts* :—It should be mentioned that any defective parts noticed within 1 year of running of the plant could be replaced free of cost.

(*l*) *Special services* :—If any special services to assist in erection of the machinery, its initial running have been put forward by the suppliers they should be detailed, and also whether free of obligation or at a certain settled schedule of wages for the foreign experts.

(*m*) *Special features of the machinery* :—If there are any special working features of the machinery claimed by the manufacturers in their offers they should be detailed in the acceptance to the tenders.

Receipt of the machinery :—

Besides proper care for storing of the machinery which has been dealt with separately it is necessary to check up contents of different packages as they reach the destination. It is essential to possess the packing lists and the preliminary inspection notes prepared in the country of manufacture or at premises of the firm's agents in Pakistan at the time of checking the machinery. Any shortages or defects noticed should be pointed out to the suppliers forthwith.

V. Lay out planning for the factory units :—

The Entrance.—Proper planning of the entrance to a factory is of great importance for efficient control of labour working. If congestion in the pedestrian, cyclist or motor traffic is not removed at this point it will be a serious set back in the efficiency of the mill. Some of the essential units which are located near the entrance to a factory are listed below:—

(*a*) *Gate House.*—This is meant to keep a watch over movment of the road transport, working of the weigh bridge. guard vehicles in the parking centre and to clock in all the workers at the time of entry into the mill. It contains time office and the time siren. This also serves as a reception office to interviewing candidates on new appointment and for general use.

(*b*) *Weigh bridge.*—This is not an essential item but may be provided to facilitate checking up loads in the motor vehicles entering or leaving the mill premises.

(c) *Meter House.*—This is meant to instal all the meter services for electric supply, water supply, etc.

(d) *Car and lorry park.*—This is meant to park all road transport services. Separate garages for mill employees and for mill staff cars may also be provided at this point.

(e) *Traffic entries.*—The vehicular entry should be separate from the pedestrian entry.

(f) *Cycle Sheds.*—These sheds should be provided after the pedestrian entrance point and so located that it is possible to keep them under watch from the gate house.

(g) *Offices.*—Office accommodation varies according to needs in different factories. It may be in the shape of a small apartment consisting of a room or two on the ground floor of a little factory. Generally detached units are built close to the entrance located opposite the welfare buildings leaving enough space for vehicle parking in between. In those cases where large scale office accommodation is required it is preferable to combine with it some of the welfare buildings like employment office, which should be located on the ground floor. Office of the works manager should also be located on the ground floor positioned in such a manner that it enables him to exercise an easy watch on the factory working. General management and sales branches should be located on the first floor. Laboratories, research rooms drawing offices and record rooms should be located on the top floors.

A typical lay out of a factory showing the above mentioned units is exhibited in Appendix No. 2.

(h) *Welfare buildings.*—Welfare buildings can be classified under 3 categories. Buildings for employment services, buildings for medical aid, buildings for food and recreational facilities. In small factories all the three types may be grouped together to form one unit preferably located close to the entrance gate, with proper planning so that the recreational buildings are connected with play grounds, swimming tank etc., and the employment office connected with the main office. Medical services should be linked up with the main factory building. In very big factories each of these three units is composed of a self-contained building catering for requirements of the staff in charge independently. In very small factories these buildings form part of the main building itself. A typical lay-out of such buildings is shown in Appendix No. 3.

(i) *Sanitory, Toilet and Cloak room facilities.*—It is not customary at the moment to cater for the requirements of labour for bathing, lavatory and cloak room needs in our country. However the day is not far off when labour organisations will demand these things as a matter of right keeping in line with provision of such facilities in the more developed countries. It is beneficial for the mill proprietors if at this stage they cater for these amenities for the labour to some degree. Whether a particular process justifies for the labourers to change their clothes before commencing their day's work or whether after a day's work they are forced to have a wash (depending on nature of the work) before returning home it is desirable that to some extent these facilities must be provided.

The best site for the cloak room is near the gate where the clothes left by the workers can be guarded. The baths, lavatories etc., should also be provided adjoining the cloak room and close to the labour welfare building. In some of the western countries particularly America there is a system of placing the latrines in middle of main factory buildings to save time for the workers to go to detached units. The side walls are kept only for the manfacturing process with adequate light. However this is true of very big factories and can be dispensed with in the case of our comparatively small factories.

(j) *Drinking Water.*—Drinking water facility should be provided at convenient places accessible to all the workers. Every effort is to be made to rule out the possibility of contamination of the drinking water. The fountains for supplying this water should have "Drinking water" written in clear words. Drinking water facility should not only be provided in the welfare buildings but also in the main factory building at suitable points.

(k) *Food Canteen.*—A canteen in its simplest form is a room where workers may bring their own cooked food, can warm it up and have proper facility for eating. Compared to his are the modern canteens where everything is served under cooperative organisation mostly. Requirements for starting from a peon right upto the mill manager are catered for in this canteen. It is completely air conditioned. Whereas it may not be justified to have such expensive canteens in our factories they must be provided to cater for requirement of our workers determind after thorough study of their exact needs.

The best site for a canteen is near other welfare buildings. It is therefore better that all of the latter are placed close to the

entrance gate but outside the main premises of the factory so that after office hours if workers want to use the canteen or other recreational rooms they can easily do so. These buildings should have connection with the residential labour area through direct street connection.

(*l*) *First Aid Centre.*—The medical aid buildings should have facility to administer first aid, facility for dental treatment and facility for medical examination prior to employment or at periodical examinations during the service period. In elaborate medical aid buildings requirement of both men and women are provided for sparately. Separate rest rooms, examination rooms and wards are provided.

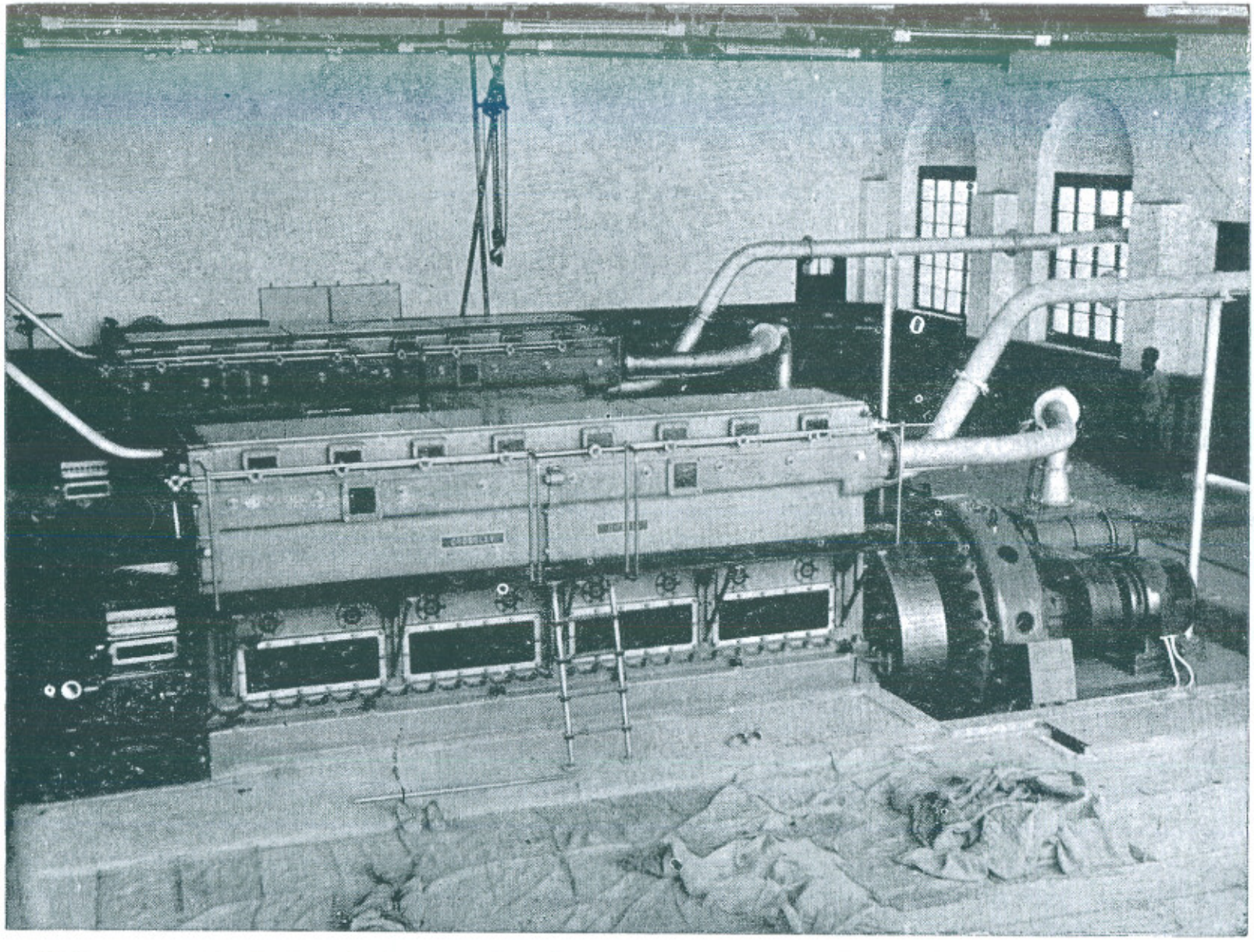
The size of a first aid centre will depend upon the nature of work in the factory and number of injuries expected. It also depends upon the number of candidates to be examined for first recruitment to service or for the periodical medical check up. The unit should be so sited that it is at a very convenient distance for that section of the factory, where most of the injuries are expected.

(*m*) *Miscellaneous welfare facilities.*—Some of the factories cater for evening classes to teach apprentices in the trade schools which are improvised in the factory workshop. The employers should rightly feel that the amount spent on the welfare facilities will result in better health of the workers and will mean less sick days and more out put. The money spent for providing such an amenity both during the working hours and after is therefore fully justified from the production point of view.

Units such as schools, hospitals, clubs, sports facilities, etc., are dealt with separately under residential colonies.

Structures for Power for the factory:—

Sources of power may be steam, electricity or both. If steam processing is essential then boiler houses are a necessity. It may be investigated whether by production of high pressure steam and working the steam turbo generators through back pressure it is more economical to generate electricity rather than purchase from a hydro electric supply in bulk. If the hydro-electric source is not dependable local generation of electricity may have to be done as a stand by source. Whatever the case the detailed location of power units such as steam boilers, steam turbines, diesel engine generators, cooling tanks transformers and meter houses can be done after a definite system is decided upon. If large scale steam production is not necessary it may be more advantageous to put up diesel engine for working the generators and work the boilers on waste heat recovery system for small steam requirements. Use of coal should be avoided as far as possible. Even the steam boilers should have oil fired furnaces.



This generator is diesel engine operated and meant to run a cotton textile mill. Not only improper alignment and levelling has been done while casting the machinery foundations but also roof of the power house has been kept too low to accommodate an overhead crane. The roof had to be raised by about 6 ft. to instal the crane gantry subsequently.

Total requirement of oil to be used and different grades should be known so that oil storage structures and oil feeding towers can be properly designed and located.

The orientation of the power unit buildings in relation to the main factory building depends on various factors based on different requirements. Following are some of important points to bear in mind :—

(1) Transport facilities for the fuel, for the machinery and repair services whether by rail, road or navigation.

(2) Location of the building with maximum demand of power particularly for steam supply.

(3) Location of the water supply for the cooling towers.

(4) Direction of prevailing winds for removal of smoke from the chimneys.

(5) Disposal of refuse etc.

(6) Facilities for future extensions.

(7) Location of the workshop.

The power buildings require suitable lay out of the railway sidings and minimum possible distance from the points of demand. If steam heating of some of the buildings is to be done in cold weather that too should be kept in view.

Material stocking buildings and silos :—

Their utility is especially to store raw and finished products. Their location is to be decided in relation to the process they have to feed or considering the finished product section. The orientation and detailed lay out is to be further governed by lay out of the railway sidings and the roads. For fixing heights of different basements the finished formation levels of the railway sidings or the roads must be kept in view. Design of loading and unloading platforms has also to be effected keeping these things in view.

These store rooms are single storeyed or multi-storeyed depending upon the quantities of products to be handled. The floors have got to be extra strong to stand shocks and rough handling of heavy consignments. In the case of multi-storey buildings the upper floors should be so supported as the columns should not encroach upon the useful available space. The floor heights should not be excessive for easy handling of stores—heights upto 9ft. will be adequate.

Sometimes packing is done in the store rooms themselves. Relative position of the packing compartment compared with the storage section is to be determined considering the location of the finished product operation.

In certain schemes hoists are utilised for handling the packages from the warehouses into the railway or road trucks. They should preferably be in pairs to avoid disorganisation due to breakdowns. Very often a combined operation of despatching; partly packed and partly unpacked articles has to be handled in these store houses and their working should be placed accordingly. In most of the lay outs the warehouse for raw products are located separately from those for the finished products. The former are located close to the railway siding or the road considering that greater weight is to be handled in these sections than the finished products godowns. The latter are commonly placed close to the test laboratories and the packing section if it it is located separately.

Whether the transport facility is by means of rail, road, canal or river navigation or combination of any of these systems the warehouse should be so sited that there is the least possible cross traffic which introduces interference in efficient working of the mill.

Silos:—

Raw material to feed certain industries is of such a nature as to necessitate construction of silos for their storage. For extraction of vegetable oils both edible and non-edible, the seeds can be stored in these silos with advantage. It is preferable to construct these silos out of concrete and circular shape where large storeys are involved but for smaller capacities other polygon shapes could be adopted.

Loading and un-loading platforms:—

These platforms are required either for road or railwuy transport or for both. For planning of the road platforms the following points should be kept in view.

(1) Size of the vehicles must be considered to fix height of the platforms and road width as well as radii for the road curves.

(2) The loading ramp may be continuous in one length and parallel to length of the warehouse or it may be in shape of docks all placed in a series at right angles to the longitudinal dimension of the store godowns.

(3) It is desirable to cover these platforms for protection of goods against weather.

(4) Vertical clearance of the platform shed should be kept about 18 ft. to permit the biggest road truck.

(5) As regards design of the platforms for railway wagons the railway authorities should be consulted about the schedule of their dimensions both in the horizontal and vertical directions so that there is no infringement of moving dimensions. For broad gauge wagons the face of the platform wall is kept 5′—6″ from the centre of track and its

height 3′—6″ above the rail level. Vertical clearance from undersurface of the platform cover to top of the rail should be 13′—6″ provided the cover does not extend beyond the platform face wall. Appendix No. 4 shows a typical lay out of such platforms.

(6) These platforms whether for the road facility or for the railway should be straight and level in alignment.

(7) The construction of the platform surface should be strong enough to withstand shocks from heavy consignments which may be dropped from great heights.

(8) If volume of consignments to be handled justifies mobile cranes they may be installed on the platforms which will not only save a considerable manual labour but will save the life of the structures a great deal.

Test Laboratories :—

There are a large number of industries where provision of research and testing laboratories is a necessity. The following considerations are important for their provision :—

(*a*) They should be sited close to the finished products section or to process which is particularly required to be subjected to laboratory examination.

(*b*) The siting should be done in such a manner that vibrations and the processing do not affect working of the test instruments.

(*c*) Sometimes it is advantageous to locate such a laboratory on upper storey of an office building. It is advantageous generally speaking to locate such a laboratory in close proximity to the office building.

(*d*) Facility for provision of services such as compressed air, steam, electricity, air conditioning etc., which may be required to perform different experiments should all be available in the laboratory.

(*e*) Sometimes test centres are distributed in different sections rather than their complete centralisation but this is done only in case of very large scale factories. They are called process testing laboratories.

(*f*) Experimental centres should be located close to the points where complete facilities exist.

It is not possible to standardise design of such laboratories because their shape, accommodation etc., all depend on the type of machines and testing apparatus to be fitted which will vary with different processes involved in a particular industry.

(*i*) If to commence with, the siding is required on a limited scale and it is desired to make provision for its subsequent expansion a clear idea about the immediate requirement and the future requirement should be given. In case it is found that construction of the siding prior to arrival of the machinery is not possible it is necessary to obtain technical opinion of railway authorities about the proposed lay out of the siding so that it should form an integral part of the entire planning as a single unit. Under these circumstances it will be advantageous to get plots of land on lease from railway authorities opposite the goods sidings, at the station for temporary stacking of the material to avoid heavy demurrage. The railway authorities may be requested to make available such facilities as proper goods platforms where they do not exist or their extension at very busy station where the existing lengths are inadequate. They should be kept in touch with the development of the area which is going to take place as a result of a paticular industry being set up near some station. They should be advised in clear words regarding the additional facilities required at such stations sufficiently in advance so that they can take action to accommodate genuine demands.

Criticism of specific lay outs :—

Appendix No. 5 shows an example of a factory set up in Pakistan. In this case the entire planning of the factory was done without considering the railway siding. It had to be fitted in the lay out as the last link of planning and as a result, even after the best stretching, it nearly ruinsd the aesthetic appeal of the buildings. An embankment about 6 to 8 ft. high blocked the main view. The powerhouses and finished product godowns could not be efficiently served. These snags can be easily eradicated if planning of the siding is done at the right moment. A typical lay out of a railway siding designed to serve different important units of a factory is shown in Appendix No. 2.

Shunting Locomotive for Industry .—

Realising heavy shunting cost which has to be paid to the railway authorities if their engine works within private limits of an assisted siding, generally the big industrial managements arrange to purchase their own shunting engines. In case it is settled to go in for such a locomotive it is definitely advantageous to go in for a diesel electric worked unit considering the present day conditions in Pakistan :—

(*a*) The thermal efficiency in a diesel electric locomotive is more than a steam one.



The main approach view of this textile mill which shows the administration block and the factory in the photograph is spoiled by the factory siding with its bank 8 ft. high above the ground level and running along its one face. The power house is not served at all and the godowns partially served by the siding. This is attributable to defective planning in that the main factory units were constructed before lay out of the railway siding was even thought of.

(*b*) There is saving in staff.

(*c*) Less wasteful operations such as watering, coaling etc.

(*d*) Higher starting tractive effort and its smooth development.

(*e*) Saving of the fuel and maintenance costs.

(*f*) Possibility of getting reduced wheel base engines which can successfully negotiate very sharp curves.

(*g*) For the same tractive effort adhesion ratio can be cut down and correspondingly the weight of the locomotive can be reduced.

Roads: —

The lay out of roads both for internal routing of the factory from one section to the other as well for the external approaches should be well planned. Different highway acts should be kept in view for observing road distances and siting of buildings away from the public road. In the corporation limits different building regulations should be duly observed. One of the fundamentals for designing curves and grades of the road system within the factory area is based on the type of commercial vehiciales to be used.

Internal Transport :—

The mill lay out will determine the amount of transport between prossesses. The routing from one process to the other will to a large degree contribute to efficiency of the final output. Sometimes mechanical aids like Liester type trucks are made use of for internal transport but it is necessary to consider that too much expenditure is not incurred on this item which may not bring an over mechanisation. Modern factories on a very large scale are making use of conveyors, hoists cranes etc., but their use should be well planned to replace the manual effort to an economical limit. Following points are worth consideration for an efficient internal transport :—

(*a*) Crossing of the internal routing should be avoided as far as possible.

(*b*) The flow lines should be straight and shortest possible.

(*c*) Siting of the raw material and finished product stores should be so selected that they feed or are fed from the respective processes at a very close spacing and with the maximum of ease.

(*d*) The means employed for internal transport especially the mechanical system should be provided depending upon the volume of work to be handled.

(*e*) The entry and exit doors should be properly spaced for different

units of the building considering the relation each process will have with one an other.

(*f*) Traffic between buildings should be reduced to the minimum or avoided as far as possible. This can be achieved for the new buildings by avoiding increase in their number or by installation of devices such as conveyor tubes or carriers which avoid transport and save money. If it is desired to make use of such facilities, specialised firms should be consulted for these problems.

Some idea of planning for internal routing has already been given in Appendix No. 2.

Residential colony :—

The type of quarters to be constructed for low paid staff should be selected after proper thought and consideration. Different government departments have standardized plans for construction of class IV type quarters for their low paid staff. It should be considered whether to select one room or two room quarters but any type chosen should have proper cooking space and the bathing facility. Keeping in view labour trends it is proper that any planning which is done to-day and will be in operation for many years to come should take into consideration the changing circumstances demanding more and more amenities for the factory labour. The selection of the type of quarters from among different type designs should be based on these requirements.

The colony should be so sited that it does not interfere with the future expansion of essential service building units of the main factory. The lay out of the colony should not be a crowded one but properly spaced. Facilities such as mosque, schools, hospitals not forgetting the graveyard should cater for need of the majority of the workers and located for convenience of this colony. These houses for the low paid staff should be isolated from the residential area for thes supervisory staff and officers' bungalows with green belts interpolated at appropriate spots.

Schools :—

The design, type, capacity and lay out of the schools should be determined by the system of education and standard of the school. If there are any regulations published by the education department to be followed for construction of the schools they should be adopted. While siting the school buildings following poins should be kept in view :—

(*a*) Easy access from the homes of children especially far the small age group.

(*b*) Quietness should be catered for. Nearness to bazar, factories etc., should be avoided. ure town d evelopments should be duly considered,

(*c*) Sufficient area providing facility for play grounds, future expansion etc., has to be earmarked.

(*d*) For very young children it should be considered that the school should be accesible without crossing very busy roads.

(*e*) The entrance gate should be properly located so that as far as possible heavy trafficked roads just in front are avoided.

(*f*) Close proximity to public parks, gardens etc., is an advantage.

(*g*) Sites selected should be reasonably level so that expenditure on levelling out for provision of play grounds is avoided.

(*h*) Annoyance caused to surrounding houses by location of the school at a particular site should also be considered.

(*i*) Water supply, road, sewage disposal services should be given proper thought.

((*j*) Position of units such as science section, laboratories etc., should be well planned with respect to the entire lay out of the school.

(*k*) If any technical schools are to be provided special provisions in their respect should be considered.

Hospitals :—

Bed requirements of a hopital is the first consideration towards its planning. The other points to be kept in view are given below :—

(*a*) The lay out should be as compact as possible because on it will depend the working efficiency.

(*b*) Light and ventilation should be very adequate. Provision for maximum sun into the wards at some time of the day must be made.

(*c*) The connection with the wards and administration section should not reduce the efficiency of working.

(*d*) Out patients and casualty departments should be sited as close to the public road as possible.

(*e*) Those departments which have to serve both the indoor and outdoor patients should be suitably placed.

(*f*) The Nurse's home should be sited as a detatched unit from the main hospital building.

(*g*) The mortuary unit and the grave yard should be sited out of general sight from the wards. It is desirable to give it a separate entrance from the public road.

(*h*) Different circulations required for efficient working of a hospital should be properly considered.

(*i*) If any rooms or wards are to be especially provided for infectious diseases they should be prcperly isolated from the main hospital building. Different regulations needed for the design of infectious diseases hospitals should be kept in view.

Water Supply :—

Estimate for the requirement of water supply to feed different demands should be accurately framed. Some of the services to be considered for this are as follows :—

(*a*) Initial and temporary requirements for building purpose.

(*b*) Supply of power such as steam for processing or for generation of electricity. Cooling towers and tanks.

(*c*) Different processes in the main factory.

(*d*) General services such as : air-conditioning, humidification, steam heating etc.

(*e*) Domestic supplies after considering total population and water demands in the public buildings such as hospitals, baths, swimming tanks, clubs and other labour welfare buildings.

(*f*) Fire fighting services.

(*g*) Trade waste and sewage disposal.

(*h*) Cultivation, gardening and turfing.

(*i*) The capacity should be based on maximum daily flow simultaneously with the required fire flow. Distribution system design is governed by the fire flow.

After calculating the present day maximum requirement a provision should be made for future expansion on a basis of about 20—30 years. Of course the short period demands for the building purposes which have been dealt with under the trial bore heading should not be considered for the permanent requirement.

(*i*) *Tube well supply* :—

At most of the sites a good sweet subsoil water is a pre-requisite for selection of a factory. It will be tapped by means of deep tube wells. The number of the tube wells and their sizes should be fixed on the maximum future demand as estimated above. A fairly accurate idea of the yield from a particular aquifer per foot length of the strainer or slotted screen of given diameter is necessary to fix these essential characteristics for which performance of the existing tube wells in the vicinity if any

should be studied. The trial bore if conducted will solve this problem successfully.

(ii) *Siting the water supply installations* :—

The tube wells should be located after complete lay out plan has been finalised. This should feed the high service tank from the nearest distance. The latter should be sited at some central place to cut down cost on the rising and distribution mains. Height of the ground is another consideration to be kept it view to cut down the expenditure on height of the tank staging and extra pressure against which the pump will have to pump on the delivery side. In those cases where variation in the ground levels is too much it should be compared as to which will be more economical : reducing the height of staging by building the tank on higher contours or reducing the length of the rising main and head against which the pump will deliver the water by locating the tank nearest to the tube well. This is particularly true in those cases where site of the tube well cannot be varied.

Height and capacity of the service tanks should be fixed considering the requirement for fire fighting service, the highest point to be served with water supply and consumption of water in 24 hours. Normally the storage capacity equal to 1/4th daily demand is adequate particularly where stand by water supply arrangement exists, otherwise equal to 1/3rd of the daily consumption.

(iii) *Installation* :—

Before deciding a contract for boring of á tube well it is essential that the agency selected should be dependable and capable of delivering the goods within the promised time. In most of the cases it has been seen that in a hurry, work for installation of the tube wells is entrusted to such contractors who delay their completion beyond imagination. It will be a wise step to make a proper selection for nomination of the contractor to instal the tube well. If the strata is a bit difficult machine drilling should be preferred to hand boring which will not only cause unwanted delays but will be very much uneconomical. At the moment there are very few agencies in the market undertaking machine drilling and generally their rates are unreasonable because of lack of set organisations.

It will be a wise step to keep the size of the top length of the tube well bigger than the lower portion so that it should provide setting for the bigger size deep well turbine pump. Diameter of the strainer and blind pipe below will be less With this arrangement bigger put out can be worked at an economical investment.

(*iv*) *Pumping Machinery* :—

The pumping machinery should be so selected for which the suppliers ensure satisfactory servicing facilities. The delivery period should be suited to the demand and price competition in the market. In case of oil engine installation it should be preferably horizontal type and slow speed (not exceeding 600 to 800 R.P.M.). If electrification is to be done after sometime provision for that must be made in the pully arrangement for the belt drive with a dual drive arrangement whereby conversion may not be difficult later on. It is proper that suitable stand by arrangements should exist to pump out water in the event of failure of the main engine or electric supply. This will require duplicate oil engine installation on one of the main tube wells at least.

(*v*) *Treatment of the hard and turbid waters* :—

(*a*) If at all it is necessary to treat hard waters before being consumed in an industry, water softening plants will have to be installed. If water is from canal or a river its filtration prior to softening will also be necessary. The type and capacity of the softening plant will be determined by the capacity of the raw water and the composition to which it should be reduced for a particular process. There are different systems like lime soda, zeolite, Nalco etc., being followed for this purpose and a careful selection is necessary.

(*b*) *Filtration and chlorination* :—For industrial use presure filters are used to filter turbid water supplies. However where domestic supply is also combined it is more efficient to go in for a rapid gravity sand filtration process for better bactereological purification, economy in space and first cost as compared with a slow sand filter. Sterilization by means of chlorine should be done for domestic supply only. This will necessitate separate storage tanks both for the factory processing and for the human consumption. Appendix No. 6 shows a typical rapid gravity sand filtration and chlorination scheme for consumption of about 1 to 2 lac gallons per day. It is quite simple to maintain and cheap to construct as compared with either a pressure filter or a slow sand system.

(*vi*) *Control over wastage of water* :—

All possible steps should be taken to check wastage of water at leakage points. Supplies may be metered and regulated in the residential areas. Automatic cut off control devices should be installed to eliminate over-flowing from the high service tanks. The faucets, hydrants and other fittings should be of robust design and their maintenance should be prompt. Pipe line should be properly looked after.

VIII. Treatment of Industrial Wastes :—

General :—

The predominent requirement for industrial waste control is more to check pollution of streams or complications caused to the town sewage disposal system than the profits expected by the recovery operation. Waste pollution varies with different type of industries and the intensity of pollution from one factory varies throughout a working day. The following table will give an idea about the equivalent population strength of the waste from different types of industry :—

Industry.	*Population equivalent.*
(1) Dairy and Creamery	... 800 to 1000
(2) Paper Mill	... 4000 to 5000
(3) Tannery (Vegetable)	... 18000 to 20000
(4) Cotton Textile Mill	... 2500 to 6000
(5) Silk Textile Mill	... 15000 to 22000

Data for an industrial waste study :—

(*a*) Complete flow diagram for the industry.

(*b*) Volume of waste from each process.

(*c*) Length of time of flow of each process.

(*d*) Complete chemical and biochemical analysis of each waste and combined waste.

(*e*) Analysis of body of water receiving waste.

(*f*) Study of final disposal of body of waste-receiving waste.

(*g*) Is it possible to produce any by-products from the waste ?

(*h*) Can processes be changed without much interference to accommodate more efficient industrial waste disposal ?

(*i*) Can qualities of waste be changed by re-using the wash water for any other processes ?

(*j*) Can some wastes be used to treat other wastes ?

(*k*) What is the effect of the industrial waste treatment on economy of the industry ?

(*l*) Will the waste deteriorate the sewage system ?

(*m*) Will the waste respond to existing treatment process or interfere with it ?

(*n*) How will the additional load affect the sewage treatment ?

The wastes can be broadly classified into two categories. The first type of wastes are those which are treated with a definite aim of recovery of profitable ingredients. While calculating the degree of profit, price of the material finally salvaged should be added to the cost of proper waste disposal in absence of such a treatment and then cost of the process should be deducted. The other type of wastes are those which hardly possess any value.

Site survey :—

At the time of location of an industry the influence of the trade wastes on the sewage system of a town if they are to be admitted into the city sewers or on a stream must be studied. Tha sewage disposal in the former case may become too much complicated by joining in of the industrial wastes and the treatment plant may have to be re-shaped. It may not be possible to admit the waste into a stream considering the intensity of pollution, inadequate self-purification and statute of the riparian rights. There may be instances where the effluent may contain harmful chemicals prohibiting its use for cultivation. In such cases it is binding that pretreatment of the wastes must be carried out. There is tendency these days to cut down the wastes to the bare minimum possible keeping in view the keen competition for the industrial products. However it is not possible to ignore these wastes altogether and they demand an important consideration at time of planning of a mill. Survey of the proposed site, survey of the existing town sewage disposal system and stream sewage with minimum possible flow, are essential.

Characteristics of Wastes :—

The characteristics of different wastes depending upon the type of industry call for different treatments and therefore different structures for the processing As an example it may be considered that wastes from a tannery contain nitrogenous organic compounds in suspension and some in solution. The treatment will concentrate mainly for neutralisation and sedimentation. Paper mill wastes contain cellulose and inert compounds in suspension. Here coagulation and sedimentation will be able to achieve the required recovery.

Study of different treatment processes :—

There are a large number of treatment processes for the industrial wastes which are selected for individual cases after thorough analysis of the effluents and examination of the source of final disposal. They are enumerated below :—

(1) Disposal by dilution.
(2) Disposal by irrigation.
(3) Primary treatment.
    (*a*) Screening and grit collection.

(*b*) Grease and oil removal.

(*c*) Sedimentation.

(*d*) Sludge digestion.

(*e*) Sludge drying.

(*f*) Sludge incineration.

(*g*) Gas utilisation.

(4) Chemical treatment.

(*a*) Neutralisation.

(*b*) Precipitation.

(5) Secondary treatment.

(*a*) Biological treatment.

(*b*) Activated sludge.

(*c*) Biochemical treatment.

(6) Chlorination :—

Output of effluent :—It is necessary to get the advice of the machinery manufacturers about average and maximum hourly flow of waste liquid for the process. They should also give their opinion about approximate quantity of biochemical oxygen demand for a known period to treat the waste sludge because on this important factor are based the capacities of most of treatment units like bio-filter beds.

Importance of tradewaste disposal :—The problem of industrial waste treatment does not form a primary consideration for choosing the site of an industry but it certainly carries a great importance to deserve a preliminary planning to avoid a number of complications subsequently. The waste treatment may not be financially justified but with a given location of a factory it may become essential to carry out a particular processing before its admission into the public sewage system or into a stream is permitted. In case it is considered to adopt a complete treatment to obviate necessity for such an admission into any of these systems the cost may become too exhorbitant. There may be quite a few instances where with a particular treatment the effluent could be pumped and utilised for irrigation purpose and additional expenditure may be justified considering the return expected from sale of the water devoid of harmful chemicals. The problem of the trade waste disposal has to be considered essentially based on a particular industry and to a large extent on the environments in which the industry is located. This is one of the items where pre-planning is necessary and should not be kept pending till the actual manufacturing process commences as is the general consideration. In fact all the treatment structures like outfalls into rivers, sedimentation tanks, coagulation, floceulation and filtration basins,