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UNIDO/DECHEMA Seminar on Operation, Maintenance, Design and Manufacturing of Chemical Plants and Equipment in Developing Countries

Königstein (Taunus) near Frankfurt/Main
Federal Republic of Germany
25 - 26 June 1970

REALIZATION OF CHEMICAL PROJECTS IN DEVELOPING COUNTRIES

CASE STUDY 1/

by

Dipl.- Ing. M. Huguenin
stellv. Direktor
CIBA Aktiengesellschaft
Basel 7, Switzerland

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SUMMARY

REALIZATION OF CHEMICAL PROJECTS IN DEVELOPING COUNTRIES CASE STUDY [1]

by

Dipl.- Ing. M. Huguenin
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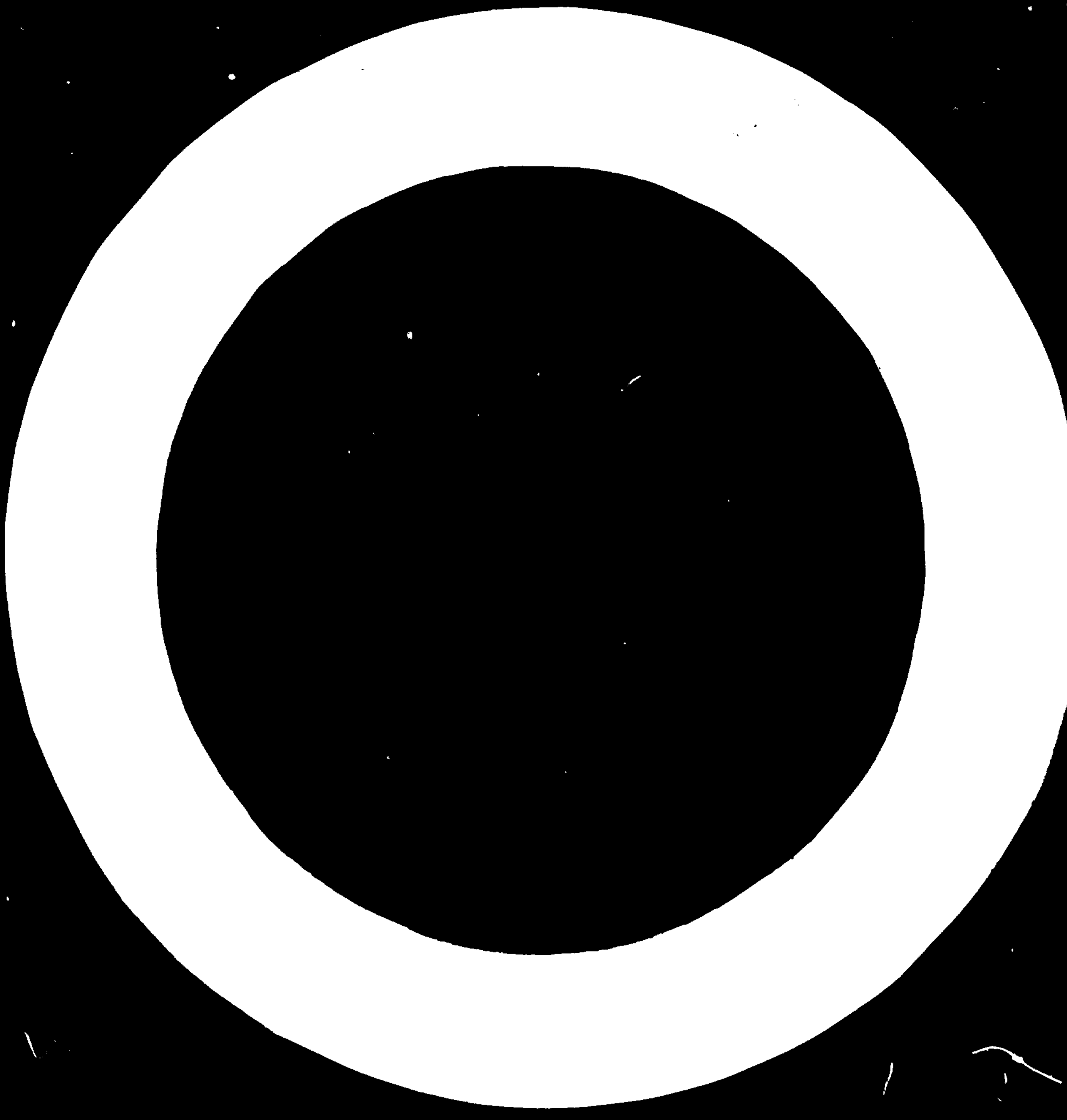


The preceeding paper gave the general rules governing the ideal sequence followed by a contractor when implementing investment projects in developing countries; this exposition cites an actual case study to illustrate their application in practice.

Part I gives Ciba's procedural pattern for the normal implementation of a construction project by the user, the differences to Uhde's general procedure being explained.

Ciba's procedural pattern consists of 7 phases, i.e.:

1) Investment proposal
2) Feasibility study
3) Pilot project
4) Final project
5) Construction
6) Commissioning
7) Assessment of results

These are described, some of them in considerable detail, in order to emphasize the importance of proper of planning, schedules and clear decisions.

Ciba's pattern differs from Uhde's general procedure in Ciba being primarily devised for the construction of multipurpose plants; Uhde is concerned with the construction of large mono-product installations.

Compared with Uhde's task of selling a new product in a developing country, market analysis, financing and choice of site require a different approach when proven and standardized production methods are transferred to an already established outpost.

Part II of the exposition is the actual case study: the construction of pharmaceutical manufacturing facilities for sulphonamides at Atul, a little town 300 km north of Bombay in India. In dealing with the pilot project phase, emphasis is put on precautionary measures specially needed in developing countries, e.s. clear division of responsibility, preparations on construction site, influence of import restrictions and finance.

In describing the final project, the construction and the commissioning phases, special attention is paid to points where particular difficulties occurred:

- Cooperation with the contractor
- Standardisation and selection of equipment
- Model
- Ordering supplies and equipment
- Acceptance testing of equipment
- Packing, marking, storage and shipping
- Costs and deadlines
- Assembly, pipework, welding, insulation, instruments, auxiliary installations, ventilation and air-conditioning plant, steel construction elements
- Commissioning

and Plant operation.

A time table illustrates why it took longer to carry out the project than the 4 1/2 years we would have needed in Europe.

The paper ends with conclusions and recommendations, and with a plea to attack pollution problems before it is too late.

REALIZATION OF CHEMICAL PROJECTS IN DEVELOPING COUNTRIES

a) General procedure (UHDE - Dipl.Ing. Witzel)

b) CASE STUDY (CIBA - Dipl.Ing. Huguenin)

Introduction

The preceding paper gave you the general rules governing the ideal sequence to be followed when implementing investment projects in developing countries, so now I should like to use an actual case study to illustrate their application in practice.

But please bear in mind that Mr. Witzel has described the project management for the construction of large mono-product installations from the contractor's point of view, whereas I shall illustrate the realization of a multi-purpose pharmaceutical plant from the user's point of view.

My exposition will consist of three parts:

Part 1 : Procedural pattern for the normal implementation of a construction project by CIBA (user) as compared with the general procedure adopted by UHDE (Engineering Firm). Differences are explained.

Part 2 : Application of the normal procedural pattern to the construction of a pharmaceutical/chemical plant in India (case study).

Part 3 : Conclusion and recommendations.

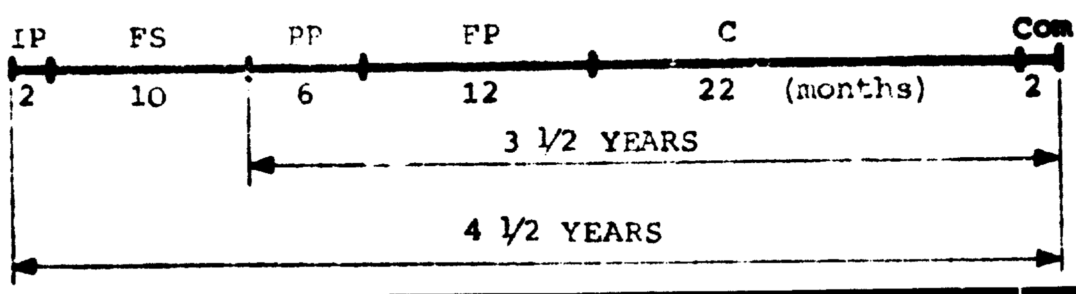
- - -

Part 1 : Procedural pattern for the normal implementation of a construction project by CIBA

As a rule a project goes through 7 phases:

- I) Investment proposal
- II) Feasibility study
- III) Pilot project
- IV) Final project
- V) Construction
- VI) Commissioning
- VII) Assessment of results

Standard time table



I. Investment proposal

The proposal to be submitted to management covers the following points: (check list)

1. Description and justification of project
2. Project variants
3. General order of initial and subsequent capital outlay required
4. Preliminary assessment of profitability
5. Suggested deadlines for planning, construction and commissioning.

II. Feasibility study

Chemists, chemical engineers, research and production engineers form a team either to look into a new production process or to modify and modernize one already in use.

Depending on the scope of the work to be done on the feasibility study, it may be continued after work has already been begun on the pilot project.

III. Pilot project

Aims and importance

In the pilot project phase, the future production chemist of the unit to be constructed and the engineering services, develop possible alternatives and variants to the stage at which management can decide whether or not to go ahead with the project and, with reference to the company's aims, set out the limiting requirements which must be met.

Once the pilot project has been approved it becomes the mandatory framework within which the final project must be realized (variants, financial limits, profitability!).

The pilot project is made up of the following sections: (check list)

1. Aims and justification

   1.1 Description of project (as in I.1)

   1.2 Proof and justification of need for production facilities:

   - Assessment of state of market (sales predictions, etc).
   - Statement of own intentions within framework of planned divisional investment and return on investment.
   - Available production capacity and reserve, capacity.

- Extendable structures already owned.
- Reasons for selecting suggested site.
- Assessment of project priority.

2. Description and evaluation of the various methods by which the project could be implemented:

Alternatives to project, and variants for realizing project.

3. Recommended solution

- Site and layout of plant (sketches).
- Construction work, terms of reference, space allotment, reserves, provision for subsequent extension (sketch).
- Flow sheet, material flow, equipment list, organization of task force.
- Flexibility of installation and possible alternative uses.
- Utilization of existing reserve production capacity. (outside main project)
- Utilization of auxillary installations (power plant).
- Effects on service departments and storage facilities, etc.
- Safety measures and security aspects.
- Waste treatment requirements.
- Raw materials requirements and procurement.

4. Manpower

5. Time required to realize project (CPM Network)

6. Estimate of capital outlay

Subsequent investments,
period over which total expenditure is to be incurred, and method chosen to finance project.

7. Anticipated business economics and profitability

Profitability estimate.
Anticipated effect of investment on overall return on investments.

Approval of the pilot project is normally followed up by commissioning architect and contractor. (Selection of architect and contractor, and the type of contract they can be offered, were reviewed in the paper read by Mr. Witzel).

IV. Final project

Aims and importance

The final project is the document with which management concludes the planning stage, setting out its aims in final form and basing them on the most up-to-date data available. The supporting documents and plans supplied by the engineering services are ready for implementation; they are based on calculations and, as a general rule, on tenders.

The plans should be so complete that realization of the project can be commenced as soon as it has been approved by the Board.

The final project for production facilities encompasses the following: (check list)

1. Basis of application for authorization of project

1.1 Description of project:

Aims, brief description, manpower requirements, summary of capital outlay, commissioning deadline

1.2 Justification of project:

Market analysis,
Company goals,
Priority,
Available capacity and reserves.

1.3 Profitability:

Production costs calculated on full and 50 % utilization of new facilities.

Profitability estimate,
including Return on investment (ROI).

2. Basis for approval of credit

2.1 Plans and calculations: Set out as for pilot project except that the final project will give definitive and not recommended solution.

2.2 Calculation of capital outlay: Set out as for pilot project but more accurate.

V. Construction

In this phase the sequence is as follows:

1. Architects and engineers are taken under contract to erect the new structures in accordance with the specifications and plans previously approved.

2. Supplementary detailed plans are drawn up.

3. All machines and equipment are purchased.

4. All equipment is packed and shipped to site.

5. Supervision of installation of all equipment, machines, etc.

6. Policing of deadlines. (by a CPM plan)

7. Control of expenditure.

VI. Commissioning

This phase consists of

1. Mechanical commissioning
2. Chemical commissioning

VII. Assessment of results (final report)

1. To what extent have the planned goals been achieved ?

2. Comparison of budgeted and actual figures (costs, profitability).

3. Extent to which new facilities are being utilized.

4. Evaluation of the efficiency of the facilities built (technical and organizational aspects).

5. Comments and suggestions.

This, then, is CIBA's procedural pattern for the implementation of a construction project. I could continue by describing the way personnel is organized to plan and realize such a project, and by giving definitions of terms such as "owner", "project manager", "project specialist", and "project engineer". But I shall not because these terms mean different things in different companies, which is why I have omitted them wherever possible in my exposition.

Some differences in emphasis

I shall now go on to compare our procedural pattern with the General Procedures outlined in the preceding talk.

Please remember that the case study is the construction by CIBA of a pharmaceutical plant for the production of sulphonamides in India.

Market analysis and finance (In the proceeding paper the first objectives)

For more than 30 years CIBA have maintained a sales organization in Bombay which keeps constant track of market trends.

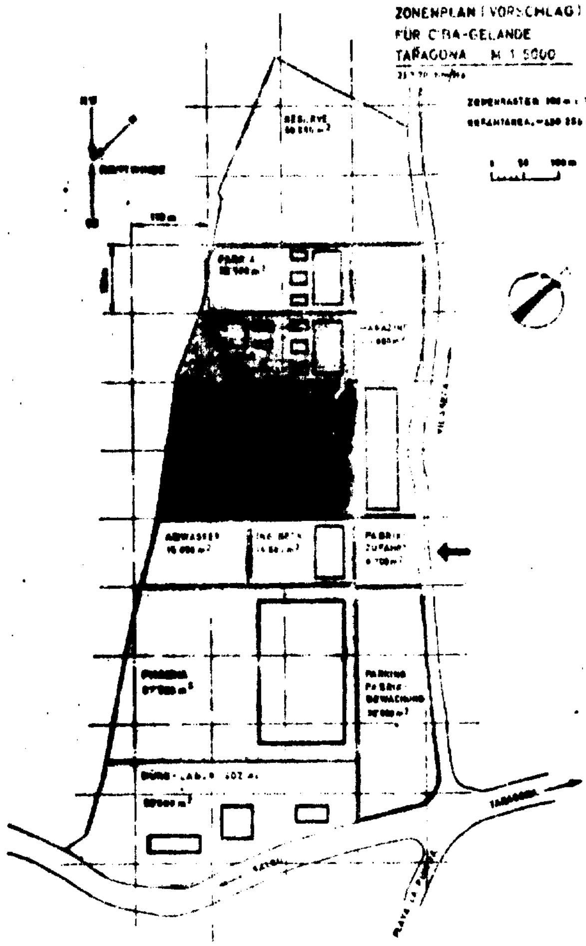
Plans to build production facilities there were sparked by a government ban on imports and by the fact that, to stay in business, foreign companies had to start producing their brands in India itself.

In this particular case, this compulsion to produce in India was not only based on the market analysis and the financial means available, but also the basic considerations of whether to stay in business or not.

The availability of a site was another decisive factor. In the case of the Sulphonamides Plant we had local partners already with a suitable site available. As a rule, CIBA are most likely to have a site already available, unless it should be a case of starting production for the first time in a country.

A detailed questionnaire is used by CIBA to evaluate and select industrial sites. All factors are investigated thoroughly because the final choice is generally a compromise; the ideal site will virtually never have ideal facilities. Waste disposal and water availability are the most important factors for a chemical site.

A **master plan** is drawn up for the whole site. Here, for instance, we have a typical master plan with various production units and their extension possibilities.



Construction according to a master plan enables a factory to grow naturally without encountering self-created obstructions at a later stage.

Master plans must be revised at least annually to take into account new developments and changing conditions.

The feasibility study is the next stage. For obvious reasons. CIBA only as a rule set up production facilities abroad for well known brands. Hence the production process employed is also known and the feasibility study for a project in developing countries is limited to its adaptation to, say, different starting materials and another environment.

In the Sulphonamides Plant (to be discribed in Part 2) there are 3 major processes conforming to the 3 phases of the chemical synthesis. Unlike UHDE's Monoproduct Plant our project is a Multipurpose Plant. The equipment consists of standard elements designed to carry out various unit operations. (Reaction, filtration, etc.).

The processes to be employed are tested and selected in our pilot plants in Basle and only the best and safest are approved for use in a foreign production plant.

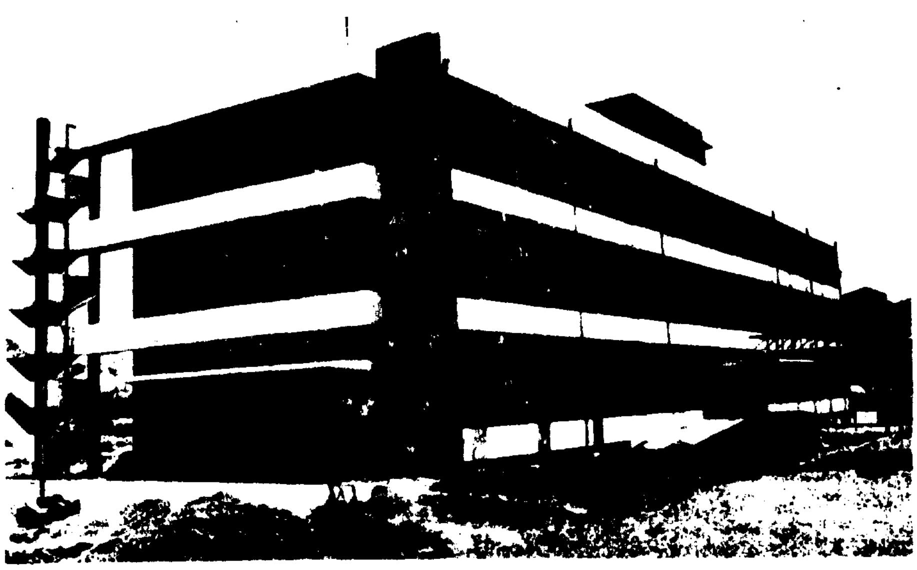
In the final project and construction phases CIBA procedure closely resembles that outlined under "Contract" in General Procedure.

I now come to the second part of my exposition, to the actual case study.

Part 2 : Case Study

I lack the time to discuss all the previously described aspects of planning as they apply to my case study, so I shall concentrate on typical characteristics and try to show what went according to plan and what did not.

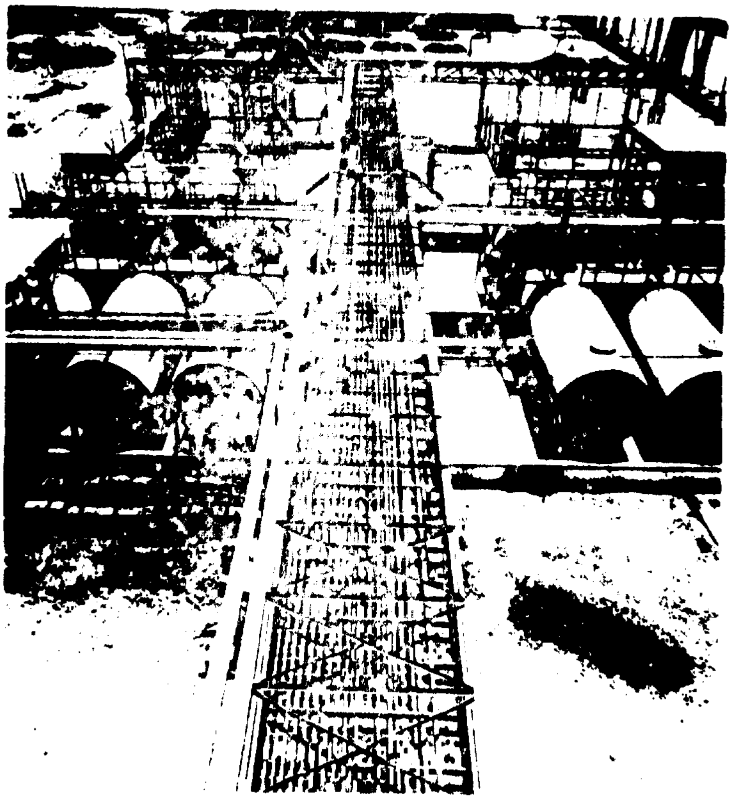
1. The investment proposal for the Indian project provides a brief description of plant and site, i.e.



Production facilities for sulphonamides, plus all ancillary installations such as

Utilities: brine, ice-water, nitrogen, ventilation, instrument air, steam, electricity, emergency power supply

Structure: multi-storey building.



Tank farm: for solvents, acids and alkaline liquors (total: 700'000 litres).

Location:

On the arm of a river. Dam forms water reservoir. Waste water is ejected below dam and is carried away by tide.

2. Pilot project

In developing countries, the pilot project and the final project include special precautionary measures. These measures are worth stressing here.

2.1 Division of responsibility

Construction of the facilities was a joint undertaking by CIBA Basle, an Indian firm (who have a chemical plant and built the infrastructure), and the contractor.

Responsibility for actual construction work was assigned as follows:

CIBA Basle

- Basic and detailed engineering
- Plans, blue prints, and processing technology
- Procurement of imported installations

INDIAN Partner

- Construction of the main and ancillary buildings using plans supplied by CIBA
- Installation of utility mains
- Procurement of tenders from Indian firms for apparatus and machines built to CIBA specifications
- Provision of construction site labour and workers' accommodation.

Contractor

- Unloading of consignments in Bombay harbour and shipments to the site.
- On-site supervision of materials assembly and installation
- Procurement of supplies from local sources on basis of tenders received by the Indian Partner.
- Mechanical testing.

This division of responsibility was inspired partly by geographical and partly by political factors. It was not a complete success.

- One partner only should be responsible for both the erection of structures and the installation of equipment and machines.

- Requests for tenders, ordering, and receipt of shipments should be one company's responsibility.

- The company carrying out the construction and installation work should also hire the labour used so that action can be taken in the case of faulty execution.

The organization of the group which will carry out the actual construction work should be laid down in advance, all the partners in a joint venture being named and having their specific tasks and responsibilities clearly defined as outlined in Part 1.

2.2 Preparations on the construction site

2.2.1 Housing and Remuneration

Accommodation for the labour force must be available when work begins. It must meet the requirements both of indigenous personnel and of European supervisors and foremen.

For our project, good men abandoned the site because accommodation was inadequate and subsequently we had to put up huts.

If there is a second construction site nearby, care must be taken to apply the same standards on both. Differences in treatment will have an unfavourable effect on morale and cause trouble.

2.2.2 Storage space

Supplies and equipment must be moved into weatherproof structures when they arrive. After consignments have been checked and signed for, the crates will not be sealed again and moisture will penetrate if they are left in the open.

The stores must be supervised by a trained storeman. He must know at any given time what is available where, and in what condition, if construction and assembly work is to proceed without a hitch.

Too little attention is commonly paid to organizing storage facilities because this is thought to be a simple task. This seemingly obvious point required a great deal of effort to put right.

2.2.3 Workshops and tools

The importance of having a workshop on the site increases with the distance to the nearest settlement.

We not only had the use of the local factory workshop but also of our own assembly workshop on the site. It was equipped with a lathe, drill, thread-cutting machine, emery wheel, saw, forge, welding bench, and all the necessary tools. It gave us very good service.

Under conditions such as those prevailing at our location, a site workshop is a necessary substitute for facilities readily available elsewhere.
The cost of the equipment and machines in it must be included in the estimates.

.3 Import restrictions and finance

As a precautionary measure information must be procured in advance on any restrictions which may apply to the importation of apparatus, machines, instruments, etc. Even then, one must be prepared for almost continuous changes in Government policies.

We referred to the flow sheets in the pilot project phase to draw up a list of parts for which we had to request an import licence from the Indian Government. In fact, we had to have two import licences corresponding to the two loans which were used to finance construction, i.e.

the Indo-Swiss Loan for Swiss made products, and
the CIBA Loan for all other imports.

The Indo-Swiss Loan import licence was granted after five months, the CIBA Loan licence after 18 months.

These two waiting periods will give you an idea of the kind of delay you will have to make provision for if you want to avoid unpleasant surprises. In our case the delay occurred because the Indian authorities struck off the list certain assembly parts they stated could be procured in India. When we tried to buy these parts in the country the manufacturers told us they could not deliver. So we had to re-submit our application for an import licence.

Import restrictions at present in force in many developing countries can require a great deal of administrative work which takes time that must be provided for in all deadlines. If you order parts or equipment before you have the import licence, you may find that you will not be able to get them into the country.

Import licences are valid only for a specific period of time. To the extent Governments will agree, the expiry dates should be chosen so that spare parts in particular can still be imported while the new plant is going on-stream.

Our licence expired before the facilities were commissioned and this caused us difficulties.

A real asset is a staff well versed in all administrative import-licence formalities and able to work closely with the people in the developing country who provide liaison with the authorities there.

Having now reviewed the precautionary measures which should be taken during the pilot project phase, we can take a look at what happens in the

3. Final project and construction phases

Once again I shall be compelled by lack of time to deal only with particularly interesting aspects.

3.1 Cooperation with the contractor

The basic and detailed engineering for our project was done by CIBA, who drew up all the plans and blueprints, built the model, and planned distribution of power and utility lines. All the contractor had to do was carry out construction and assembly on the site, procure and follow up the supply of Indian materials.

This rather unusual method of utilizing a contractor's services resulted in certain difficulties. For instance, our specification sheets were not as detailed as those of the contractor, who had to have more information than our specialists. With hindsight we can say that the contractor can do a better job if he has helped to draw up the final project, i.e. when he has contributed blueprints of the kind he normally works from.

We had a "cost plus fee" contract with our contractor (the first paper explained this term). This is about the only kind of arrangement that will cover a project where all sorts of delays and difficulties may arise.

3.2 Standardization and selection of equipment

Standardized equipment is highly adaptable and easily replaceable in the country of origin, but standards vary from manufacturer to manufacturer and the models favoured may not be easily available abroad.

At CIBA, we have gone in for extensive standardization of equipment, and our reaction vessels are of high technical standard. Unfortunately, the low-carbon stainless steel (sheet) of which they are made, and the special gasket needed for the split-section stirrer, are not available in India. On the other hand, Indian firms now make stainless steel stirring vessels which are adequate for certain requirements and well worth using.

India's shortage of foreign currency was a factor that also had to be borne in mind. Equipment therefore had to be selected so that imported reaction vessels were used only where the local product could not meet our needs.

Experience has shown that it is important to procure together with the equipment itself all the spare parts that may be needed, since wear and tear in the early stages of operation will be about twice what we would expect in our European plants. This precaution applies in particular to imported equipment, especially to vessels, instruments, pumps, etc.

3.3 Model

If the contractor presents the final project and carries out the construction work, he should be permitted to decide whether or not a model is needed. There are good reasons for and against making one.

We at CIBA put together a 1:16 scale model of the project because we knew that the construction work would be carried out by other people in faraway India. Our model was en exact replica and the best reference material we had. It was sent to India by air freight and gave very good service on the site.

Such a model is expensive and did cost about SFr. 230'000.- ($ 54'000. = 1,2 % of the investment), but it offers the following advantages:

- Chemists can check out their working methods on the model and eliminate flaws in advance, and they can use it to train operatives.

- The model provides a three-dimensional picture of the finished plant, which a layman cannot envisage when he sees only a plan.

- Engineers can use it to optimize the arrangement and alignment of pipework.

- Isometric drawings projected from the model facilitate prefabrication of pipework.

3.4 Ordering supplies and equipment

If the placing of orders for supplies and equipment is left entirely in the contractor's hands, all the modern methods described in the preceding paper can be used.

In the case of our project, however, division of responsibility between CIBA, Indian Partner and the contractor led to complications and difficulties:

- CIBA had to place orders in Switzerland in a period when manufacturers had long order lists. This meant drawing up provisional delivery contracts with possible suppliers as a hedge against long delivery periods for raw materials, although no one knew at the time how long it would take to get an import licence approved and when definitive orders could be safely placed.

- All orders had to be classified in two different categories. One set of forms had to be used to order Swiss products financed with the Indo-Swiss Loan

  and a completely different set of forms for all other supplies financed with the CIBA Loan

- In India itself tenders were requested by our Indian Partner but the orders were placed by the contractor. As previously stated, this method did not work out too well.

I may add that, to make sure nothing is forgotten, all orders should go to a single, central office to be checked and cross-checked.

3.5 Acceptance testing of equipment

All equipment should be inspected and tested before it is shipped abroad. Unfortunately, we cannot now-adays assume that apparatus is in perfect working order just because it was made in Switzerland and passed by the manufacturer's inspectors.

We had some trouble with defective equipment on a previous site abroad. You can imagine what it is like to discover, somewhere in an Indian jungle, that a set of valves is faulty and will have to be sent back to the manufacturer.

In Europe you can put on pressure and get the necessary work done fast, but in India this sort of trouble can mean a six-month delay because import licences expire and have to be renewed.

All the pneumatic valves, electric switchboards, etc. for the sulphonamides plant were therefore carefully tested before they were dispatched. A detailed inspection schedule was set up for all equipment. Apart from run-of-the-mill instruments produced in large series (which we always shipped together with a generous number of spares), everything was tested according to regulations before it was forwarded.

3.6 Packing, marking, storage and shipping

Crates being unloaded in Indian harbours are often knocked about very badly. For this reason CIBA requires all parts to be packed in moisture-proof crates which can be dropped on one corner from a height of one metre without damage to the contents.

Crates and other packing materials are expensive and their cost should be included in the estimates.

All parts shipped should be clearly marked. Labels can be used but coloured, stencilled markings are better. They ensure orderly registration and storage on the site. The markings should give the item number, a description of the part, and the order number.

All parts forwarded in crates to India were photographed and the prints were attached to the bills of lading. This system greatly simplified customs clearance because only a few crates had to be opened for inspection.

Equipment ready for forwarding is stored in the shipping agent's warehouse until enough has accumulated to make economical use of a ship's hold. Warehousing costs money.

It helps if the agent marks the crates clearly. We painted the top corners of all our crates green so that we could find them more easily in the huge harbour warehouses.

3.7 Costs and deadlines

Costs can be astounding. A simple mixing vessel, fabricated in India in the years 62 - 65 and fitted with a stirrer and heating coil did cost 1 1/2 times as much as the equivalent Swiss product after payment of freight charges and customs duties!

The feasibility of deadlines must be carefully checked and caution shown in setting up CPM-schedules. We failed to take various factors into account and considerably exceeded the original deadline. I'll refer to this particular problem again later on.

3.8 Assembly

Installation of pipework: Pipework sections and units were prefabricated in the site workshop using isometric drawings, then installed by the assembly team.

The average per diem output per man was about 3 metres of prefabricated, assembled and mounted pipework. (This is about 1/4 of the achievement in Europe).

When imported stainless steel piping is used, the electrodes employed in welding them should also be imported. We imported piping but procured the electrodes locally, with the result that welders used the wrong kind of electrode until this error was discovered during the first follow-up check.

Welding: Provision should be made in the estimates for time and money required to train local welders. We got very little acceptable work until we did just that.

In the beginning, 15 % of all steampipe weldings were rejected by the official inspector of works after they had been X-rayed.

Instruments: Local products proved satisfactory because the Indian Plant provided a good maintenance service. Vital parts are imported.

Auxiliary installations: A nitrogen plant was imported from Switzerland, but not assembled and tested before shipment because this is not normal Swiss practice. That was a mistake. The plant refused to work when we had it set up, and we had to have a specialist come out from Europe to make the necessary modifications on the site.

Ventilation and air-conditioning plant: Such equipment is available in India, and was by and large satisfactory.

Commissioning

Mechanical and chemical commissioning precedes goint on-stream. The processes covered by each form of commissioning must be clearly defined. We had difficulties with mechanical commissioning because the various authorities involved had no well - defined responsibilities.

The chemist who will supervise chemical commissioning must be nominated well in advance so that he can participate in the planning of the facilities.

3.10 Plant operation

- The quality of the machines, pumps and instruments procured from Indian sources met all our requirements.

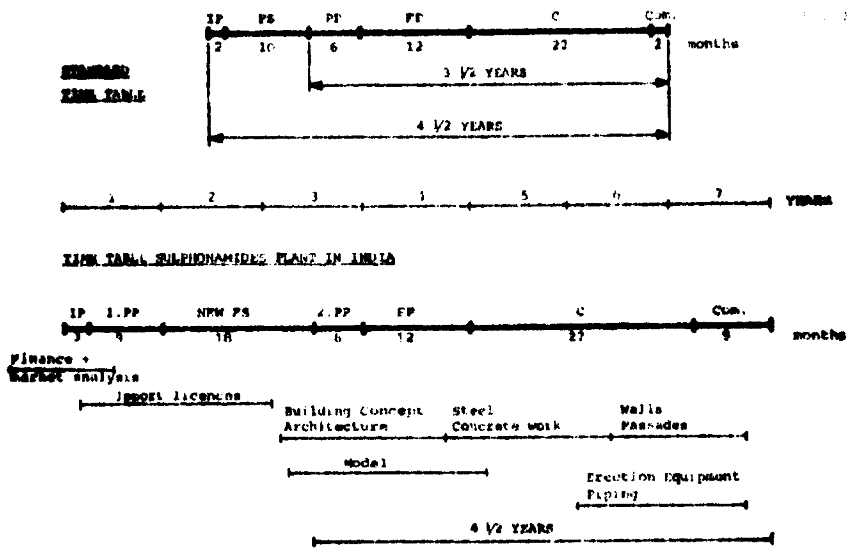
- Waste water equalizing basins (pondage) are not part of Indian drainage systems. There are not regulations requiring their construction.

- Transportation of heavy, bulky goods is a serious problem. Trucks bog down in monsoon weather and there is a waiting list for special flatbed railroad cars.

- You may have to wait for two months for a visit from the official inspector of works, so applications should be put in early.

4. Time table

The procedural pattern was somewhat different to the one to which we are accustomed in Europe. This chart will illustrate where the differences occurred.



Part 3 : Conclusion and recommendations

5. Before coming to the final words of my talk I should like to recapitulate briefly what I consider to be the most important lessons we learned in India:

5.1 Draw up your plans with the greatest care and build simple installations which will be foolproof. (Use automated equipment only where it is essential to safety. Do not use it to save labour costs. The local population needs work and wages are low).

5.2 Train your operatives in advance, but apart from a few key men in the developing country itself and not in Europe. Provide adequate accommodation for your employees. Make sure their conditions and pay are in line with local standards and customs.

5.3 Plan deadlines cautiously. Take into account the long periods during which equipment will be in transit.

5.4 Make provision for accidents en route by using packing which will protect equipment from damage.

5.5 Import enough spare parts to compensate for the high rate of wear and tear in the early stages of operation.

A few final words

We here can help developing countries to build up their own industries by supplying them with technologists, equipment, and foreign exchange. But such material help is not enough. The ordinary man in developing countries must acquire the right mental attitude to modern production methods. He needs schooling and training which take up much time but are just as important as any help from overseas. This is the field in which much still remains to be done.

We in the industrialized countries have promoted technological progress without paying full attention to what we were doing. On a long-term basis we forgot the most important factor of all, our own good health. The way in which we have polluted our air and waters should be warning enough to the whole world. And noise is going to be a greater menace than we may think today.

The developing countries still have time to avoid the pollution problems we have brought upon ourselves. Learn from our mistakes. Bear constantly in mind that by-products and waste from chemical plants should not simply be dumped in the nearest stream or sea.

Remember that every commercial chemical process should include as an integral part a means either of converting waste into new starting materials or of turning it into products that will not destroy the environment.

Only by processing waste will one be able to keep pure the air and water in big cities, and to insure the health and well-being of peoples and countries.

Thank you.

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