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Agenda item IX/2

RESEARCH AND DEVELOPMENT FOR THE FERTILIZER INDUSTRY[1/]

by

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SUMMARY

RESEARCH AND DEVELOPMENT FOR THE FERTILIZER INDUSTRY[1/]

by

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This paper outlines in the beginning the preconditions essential for industrial R+D efforts to be of successful significance. These preconditions are: (i) R+D effort in industry has to be an integral part of the industry with the associated responsibility and accountability, (ii) the institution of R+D efforts in industry has to be on the integrated multi-disciplinary team concept, particularly in developing countries where a maximum degree of self-reliance has to be achieved in the minimum possible time, (iii) the R+D Group should be a viable commercial unit on its own for meaningful contributions to flow from it, (iv) the R+D efforts should be in consonance with national socio-economic objectives and industrial policy in the establishment of a self-reliant industry with maximum potential for employment of national resources in men, material and technology. The advantages of such set up are described with illustrative examples.

A brief description follows of the organization built up in the Fertilizer Corporation of India for such activities in keeping with the above approach. Its organization, facilities and nature of work are mentioned, indicating the status of development as of today.

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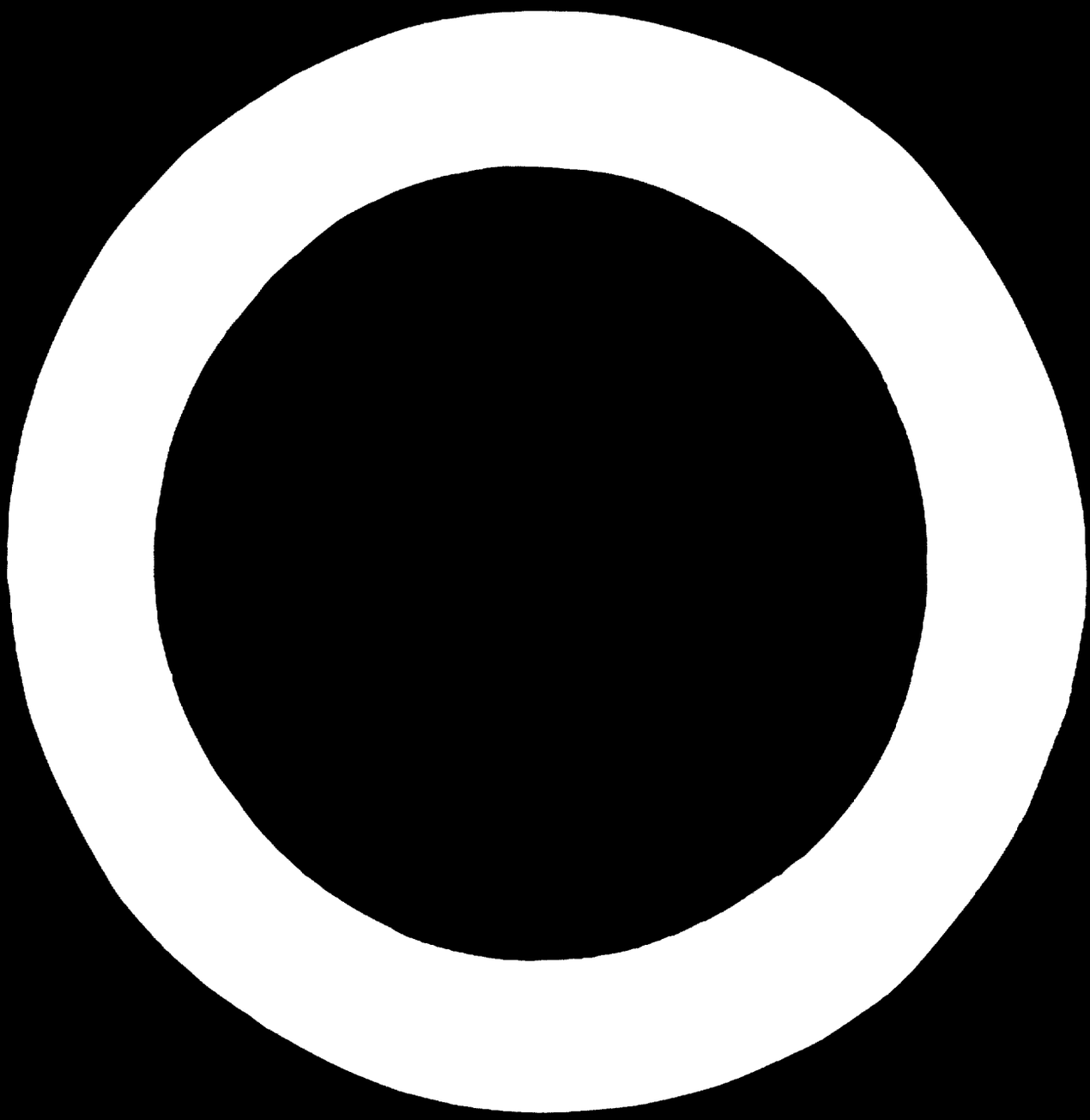
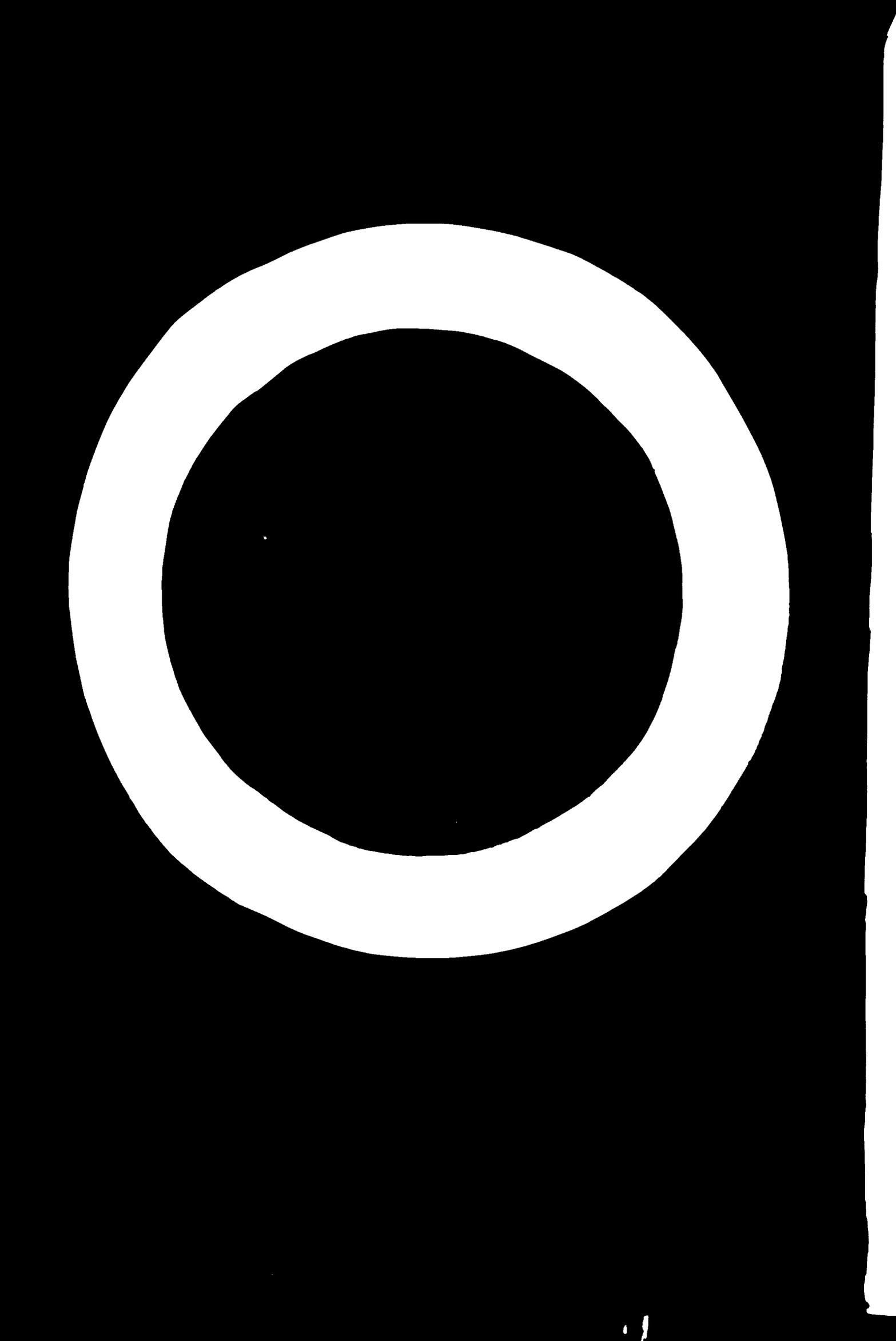




The paper, in its final section, deals with two case studies - one in the field of R+D and the other in the field of plant design engineering and installation - which are typical of the approach towards assignments and the nature of work done in the Planning and Development Division of FCI, its central technical organization. The first describes the developments in the field of industrial catalysts for the fertilizer group and the second with the first large-scale plant engineering and installation of the Rourkela Plant taken up by the Corporation. These illustrations underline the sine qua non for R+D efforts for industry to be an integral part of the industry itself.

The presentation emphasises that the philosophy of approach towards the institution of industrial R+D may have relevance to the consideration of institutionalisation of R+D efforts in industry by the Seminar.

RESEARCH AND DEVELOPMENT IN FERTILIZER INDUSTRY

1. Research and development in fertiliser industry in India had had its beginnings in the early 50s with the installation of the then biggest fertiliser plant at Sindri. Sindri itself had been conceived and executed on a turnkey basis and, in the next plant at Mangal, a good part of the work was carried out departmentally. Even at that time it was recognised that the country must build up its technological know-how base for self-reliance lest there should be a perpetuation of the pattern of package deals. Today, both metaphorically and literally, research and development in the fertiliser industry has come of age and proved that it is really the R&D effort that is the sinews of industrial development.

2. Before I deal with the evolution and nature of organisation that has been built up for R&D effort, its method of working and some of the results achieved, I consider it important that I share with this august gathering our confirmed experience on the setting up of industrial R&D efforts in countries like India which are still developing in a relative sense.

3. For the right climate for vigorous industrial

R&D effort to grow and thrive, there are certain preconditions that are essential; in fact, without these, such effort may well be of no real purport or significance.

4. The first important requirement is the structure and situation of the R&D organisation as a direct and integrated part of the industry itself. Only when the organisation is part and parcel of the industry can it be endowed with the necessary sense of responsibility and accountability for the performance of the industry, whether it be with reference to efficiencies of plant operation, achievement of production targets, adherence to project schedules etc. Then again, only when the organisation is part of the industry itself, could it be expected to be alive at all times to the problems that are faced in the industry and to promote such studies as will solve the problems immediately for maintenance of various schedules and targets. This will have a two-way interaction, when on one side, there are pressing and emergent demands from the industry itself for its viable performance from purely commercial objectives and this, in turn, puts pressure on the R&D wing for early solutions of various problems. This naturally has other beneficial

and desirable results ; for R&D to be really meaningful, it has to be constantly faced with challenges so that activity on all sides is spurred to more and more effort. This would naturally result when R&D is part of the industry where these challenging opportunities, particularly in a developing country, are bound to come fairly often and frequently. Yet another important aspect for a measurable degree of success in R&D effort towards process and product knowhow development is necessity for industrial facilities to be available to it for pilot and semi commercial scale/use of developments before actual commercial application; these facilities would best be available to R&D when it is part and parcel of the industry itself. In developing countries where balance of payments very often plays a very vital role towards industrial inputs, import substitution is a must; for this mandate to be successfully observed, only when it is part of industry can the R&D wing have the necessary background, resources and potential for achieving these objectives in keeping with the growth, dynamics and needs of the industry. If these considerations are granted and executed, it can be seen that industrial R&D and its successful performance towards the efficient and profitable growth of the industry essentially requires

a high magnitude of involvement and participation with responsibility in the industry.

5. In the institution of R&D efforts as part and parcel of industry, it was also realised in the very beginning that the various functions contributing towards a high degree of self-reliance and self-sufficiency such as R&D, pilot plants for process knowhow development and design, chemical engineering design, engineering in all its aspects, technical procurement, installation and commissioning of plants etc. would need to be developed in an integrated fashion simultaneously if an all/embracing self-sufficiency was to be achieved. In fact, the multi-disciplinary integrated team approach is the order of the day in any meaningful scientific effort and it would not need any elaboration to emphasise this point. This multi-disciplinary organisation under unified control coupled with R&D is instituted as part of the industry, with the progressive responsibility of this organisation for actual execution and design and installation of new units in the industry, the combined stakes of both the R&D and the new operating unit become important; the bond between the plant designer and the operating unit does not stop when the plant

has been commissioned but continues even further even when the unit has been commissioned and is in operation. This philosophy of approach is particularly relevant for developing countries where specialised institutional help in engineering consultancy is yet to develop and where, by this method, this necessary expertise is built up within the industry itself.

6. Apart from institution of industrial R&D effort in the above manner, it should be stressed that the results of R&D efforts in India should be considered against the economic background of the industry itself. For R&D effort to be at its best, it is evident that its own performance has to be judged on commercial lines. Its work and contributions should carry it forward on a self-generating and self-sustaining basis. For such a result to come about, it has necessarily to be on the qui vive because, after all, its growing capital will be the knowhows it has been able to generate over a period of time and on which it can earn its way through royalties, licence and engineering fees etc. It may, however, be added that, where long duration and massive plant are taken up, such institution would be requiring adequate support from the industry and the State but,

normally, such institution must be set up on commercial lines and its performance judged by its ability to pay its way through.

7. As I said at the beginning, the R&D effort in the fertilizer industry commenced in India alongwith the establishment of the first large scale fertiliser plant at that time at Sindri by the Government in the beginning of the 1950s. R&D institution had evolved in keeping with the needs and demands of the industry as it grew, keeping in view that the basic objective and endeavour of public enterprises is to determine their policies and activities so as to promote the growth of the industry with increasing self-reliance, mainly because this is the proper manner in which the interest of the country can be kept foremost. For achievement of this basic objective, industrial growth based on self-reliance should be promoted all along the line in all its facets, including choice of raw materials, usage of technology, services and supplies, choice of finished products and R&D efforts. In this, keeping relative economies in view, another important consideration is to encourage creation of employment potential and growth of national income. From this it will be seen that national socio-economic objectives and the attendant

industrial policies are of importance and relevance in the furthering of R&D efforts in industry towards the greatest degree of self-reliance.

8. In this background, one basic consideration for the greatest measure of self-reliance is vertical integration in the industry in the matter of basic feedstocks and raw materials. It is imperative that, while the technology and process should be dovetailed with availability of purely indigenous feedstocks, - R&D - efforts must be intimtely involved in playing their role in making this an economic reality. In the fertiliser industry, on which directly hinges achievement of self-sufficiency is foodgrains in a country like India, socio-economic objectives do require that industrial policy be based on the economically available indigenous feedstocks and elimination of importation of intermediates as basic feedstocks. If industrial policy would allow importation of feedstocks to a good extent, the initiative for and demand on industrial R&D effort towards development of indigenous process technology or a drive towards import substitution does not make itself felt since "Necessity", the mother of invention, is lacking and thus R&D effort does not take practical shape. The Consideration of the subject is also intimately

linked with export-import trade and hidden assets like employment and generation of national wealth. In the case of a developing country like India if import of feedstock is done to any major extent when alternate indigenous feedstock is available, it will not only increase the drain of foreign exchange but will diminish the employment potential resulting in under-employment, if not unemployment of her citizens and stagnation of national wealth. Then again, such policy could inhibit all associated areas of activity leading to self-sufficiency some of them being, besides R&D efforts, such activities as indigenous design, engineering, fabrication facilities etc.

9. I have particularly mentioned the associated aspect of employment. I would repeat here an example I had given on another occasion with regard to the national benefits such as avenues of greater employment potential that could be available if the policy were only on the concept of employment of 100% indigenous raw material such as coal for manufacture of ammonia - the primary nitrogen carrier for production of nitrogenous fertilizer - a 900 tons per day ammonia plant - the economic scale of operations - would require 0.8 million tonnes of coal per annum. On an average OMS(output per man shift) figure of 0.8 mining operations for this quantity of coal would alone afford direct-

employment to over 3000 people, not taking into account the ancillary industries which will serve the coal - mining effort such as mining equipment, transport and conveying equipment, maintenance shops and the like; Similarly, emphasis on utilisation of indigenously established rock phosphate deposits for the phosphatic industry can afford direct employment to about 1000 people for mining operations alone to sustain the rock requirements for a 50,000 tons/year P205 capacity plant. In addition, the manufacturing plants for ammonia and phosphoric acid by themselves can engage 600 to 700 people. In addition, R&D efforts towards improvement in process technology through plant trouble-shooting, innovations and developments towards indigenous technology, import substitution drives for material and process chemicals will be sponsored by such policy and will lead to gainful employment of scientists and technologists. For example, when indigenous rock phosphate will be used, R&D effort will spring from work on improvement and beneficiation studies for better process efficiency, development of processes to suit availability of other inputs available indigenously and quality of indigenous rock etc. Ancillary industries to serve the industrial - operations described above can, at a conservative -

estimate, support another 1000 employees. Thus the employment potential that can be generated by proper emphasis on indigenous feedstocks can be realised.

10. In the above, I have attempted to share the experience we have been able to gain in setting up R&D institution in the fertilizer industry in India and its evolution and growth over the last 20 years. It has been a worthwhile experience for us and I hope that it may have some relevance to the consideration of this Seminar in the matter of discussing institution of industrial R&D effort, particularly in developing countries, though some parts of our experience are applicable to any country. I would now like to deal with a brief description of how the R&D effort is organised in my company - the Fertilizer Corporation of India - and also illustrate some results we have achieved by way of case histories, depicting the background to the experience I have narrated in the beginning.

11. The R&D efforts in my company are invested in the Planning and Development Division - one of the decentralized and autonomous Divisions of our company with its own self-contained management and responsible for its commercial working on its own as a viable proposition. It is the central technical organisation of

the company wherein not only research and development - studies are prosecuted for plant trouble-shooting, for development of knowhow and products t : these are translated into practical and commercial applications through scale-ups on pilot and send commercial installations. In the integrated set-up of the organisation, all the relevant facilities for research and development such as full-fledged chemical and physical research, covering raw material investigations, various branches of technology such as gasification, gas purification, acids and salts, catalyst studies, water treatment, effluent disposal and microbiological studies, organic fertilisers and chemicals, fertilizer keeping qualities, engineering materials, evaluation and corrosion studies, chromatography as well as techniques such as x-ray diffraction, x-ray spectroscopy, ESR-NA spectroscopy, microscopy, thermal analysis, absorption spectroscopy, polarography etc. have been instituted. It will be seen that all sophisticated techniques and equipment have been provided for a self-sufficient establishment for taking on all problems related to fertiliser and heavy chemical industry. Specialist service has been set up for non-destructive - testing as part of the Physical Research Wingh which un-

dertakes periodic examination of all plant and equipment in every unit of the Corporation for soundness and for safety. A radio isotope laboratory is also part of the Physical Research Wing. this work is closely linked with the fertiliser demonstration and agricultural research department which, in addition to agricultural research, as part and parcel of the promotional activities for marketing in the Corporation renders specialist services for soil survey, soil testing, field demonstration trials etc. in various States of India.

12. The integration of research and development efforts with functions such as project and perspective planning, process design and engineering in all its aspects - mechanical, electrical, instrumentation, civil, structural and public health in an interlinked and interdependent organisation has been the basic incentive to the development of indigenous expertise in the field of fertiliser technology within the country. This type of organised working has ensured that the findings of research and development get quickly translated in plant design engineering and installation. For building the plants for sanctioned projects, a self-sufficient Project Co-ordination Group has been established for co-ordinating all activities with regard to execution of projects within the scheduled - time and budget; the group has its site organisations at the various projects which are responsible for super-

vising erection, commissioning and demonstration of guarantees. In the field of catalysts and chemicals, where continuing research is carried out to improve the products, the production and sales facilities are integrated in the Planning And Development Division itself. This Division's services are available to outside parties also for which a full-fledged commercial and contract group has been set up for selling supplies and services. The organisation is now in a position to handle 3 major fertilizer projects a year in all its phases of execution; further, it is doing jobs for many outside parties in supply of plants and services. For better coordination, recently the working of the organisation has been reconstituted on the group working concept with groups for research and development, planning process design and pilot plants, engineering, project coordination, commercial and services, and finance and accounts. The organisation is registered with the Asian Development Bank for services as consultants. The organisation is also invariably asked by potential customers in India to quote for heavy chemical and fertilizer plants. It is also in a position to license out its own process knowhows of which more than 30 have been patented both in India and abroad. It is represented on various committees set up with reference to heavy chemical

and fertiliser industry and their problems etc. Its R&D efforts, particularly the sophisticated equipment and techniques available in its laboratories, are being availed of by more than a score of institutions all over India in connection with their work where it is hampered due to lack of facilities at their end. The institution which started from small beginnings as a cell in the original Sindri factory has now become a major organisation which has been able to enter the global picture in tendering for fertiliser plants.

13. As I had mentioned at the beginning, the successful development and working of this type of organisation has been mainly due to two important reasons: 1) its efforts being part and parcel of the industry itself, it's sharing due responsibilities and accountability and 2) multi-disciplinary team approach wherein the various functions work in an interlinked and inter-dependent manner in all stages for the overall objective in view. I would now like to illustrate the results that have been possible in the fertiliser industry by the organisation with this basic philosophy of approach. Naturally, I would like to deal here with some of the earlier works which

have progressively gathered momentum and which have successively brought more and more assignments to the organisation. I would like to refer firstly to the area of development of catalyst knowhow and manufacturing facilities by the R&D Division.

14. Our research and development efforts began with the standardisation of a process of reactivation of a full charge of about 270 tons of one of the imported catalysts, employed in a key sequence of the operation which lost its activity in service very soon after the commissioning of the Sindri plant in 1951. Pursuant to the solution of the problem with imported catalyst, investigations were then directed towards development of know-how of process for manufacture of this catalyst, based on entirely indigenous raw materials and immune to the type of poisoning the imported catalyst was susceptible to. By early 1953, regular catalyst production plant was set up based upon the process developed. The catalyst was immediately taken into service in the plant and gave satisfactory service for over 4 years.

15. Success in import substitution in this case, of an imported catalyst, gave the incentive for

innovation and diversification in the same plant, utilising raw materials available from within the country as by-product of other industries and also from the Sindri plant operation itself. The ones was used with success for purification of gas in the initial stages of the synthetic ammonia stream by 1955-56.

15. These developments led to instructive insights into the general mechanism of catalysts and also gave an impetus to development of knowhow for more and more catalysts required in the fertiliser industry and establishment of commercial production facilities, one by one. For example, an improved catalyst of the first type mentioned was soon developed for pressure operation, commercial production established and taken into plant service. Similarly, during the national emergency in the year 1965, when imports has to be curtailed, another key catalyst knowhow was developed and this catalyst production established on an emergency basis and a catalyst charge from the plant was made available for plant service by early 1966. All these catalysts have proved their worth in actual plant service.

17. These results were forthcoming because of

the situation of the institution as part and parcel of the industry itself and its being faced with emergent problems needing urgent solutions. Further, its efforts could bear results because the plant facilities, such as equipment, raw materials, utilities etc were immediately at its command as part and parcel of the industrial setting. It was also the industry and its immediate problems that threw up these challenges and opportunities to the technologists. In other words, the raison de etre for these advances was the location of the development group in the industry itself as part and parcel of it.

18. Catalyst development and production programmes had thus gathered momentum and today as many as 13 catalysts for different process steps, operating conditions, raw materials processed are now available. These are now employed in plants in India, both in the Fertiliser Corporation and outside. However, we have arrived at this stage progressively. For example, in the case of the first two plants taken up by the Govern - ment on the single stream centrifugal compressor ammonia plant concept, certain catalysts were in the imported

category. In the second series of such plants, however, the Fertiliser Corporation has been able to incorporate its own range of catalysts for the whole range of operating sequences upto ammonia synthesis, starting from naphtha or natural gas, buy plant and equipment to their own specifications for employing these catalysts.

19. We often come across suggestions that duplication of research should be avoided. This may have relevance to large specific projects for which considerable national resources have to be diverted. On the other hand, FCI's experience has shown that no restraint on following particular lines of research in day-to-day work would be advisable; on the contrary, there should be complete freedom given to scientists to follow up their ideas, obviously within the overall objective of the organisations. If the concept that duplication of research is not desirable had been followed in F.C.I., catalyst knowhow development and production facilities in the Fertiliser Corporation would not have at all taken place, since, for decades, there has been hardly any scientific institution in the country, where some research problem or other

dealing with catalysts has not been initiated. If only on the grounds of avoiding duplication, the Corporation had not initiated studies, possibly the results in developing various catalyst know-how, their manufacture and saving of foreign exchange would not have taken place at all.

20. Similarly, I would also like to mention here the very first large scale venture in design, engineering, procurement and construction we had undertaken for nitric acid and nitrolimestone plants at Rourkela in Orissa, India.

21. When the Hindustan Steel decided to go in for fertiliser production from the hydrogen available as raw material from the coke oven gases in the Rourkela Steel Plant in 1957, the management of the Sindri Factory, the precursor of the Fertiliser Corporation of India, with the full acceptance of the task by its technologists and engineers submitted their tender for designing, engineering, procuring, installing and commissioning the plant on their own without purchase of any know-how from outside, amongst international competition. They had previously installed

on their own design and engineering a supplemental expansion to the Sindri Plant and this gave the necessary impetus to this venture in bidding for the largest nitric acid and nitrolime-stone plants at that time (to be put up at Rourkela) of the following capacities; 1600 tonnes per day nitric acid plant, 2100 tonnes per day nitrolimestone and 480 tonnes per day ammonia vapurisation plant with ancillaries for (a) cooling water system (b) water treatment and (c) storage and bagging and (d) silo air conditioning.

22. The magnitude of the task could be gauged from the advice rendered to Hindustan Steel by a foreign expert. He gave the opinion that, despite the tender of Sindri conforming to the technical specifications and to the offer of other tenderers and despite there being no doubt that the project would, in principle, well designed and would give expected results with regard to capacities as well as consumption co-efficients even as the other tenders, no organisation in Europe of the experience of Sindri at that time would dare to handle such a big job; in this light, he also doubted whether the Sindri portion of the plant would

be ready for operation before the ammonia plant contract for which was awarded to a foreign firm.

23. However, the job was undertaken and fulfilled by Sindri. Such a challenging opportunity could not have come and been successfully accepted if it were not the position that the development and design organisation was part and parcel of the industry intself and, therefore, the management could confidently assign this task to it.

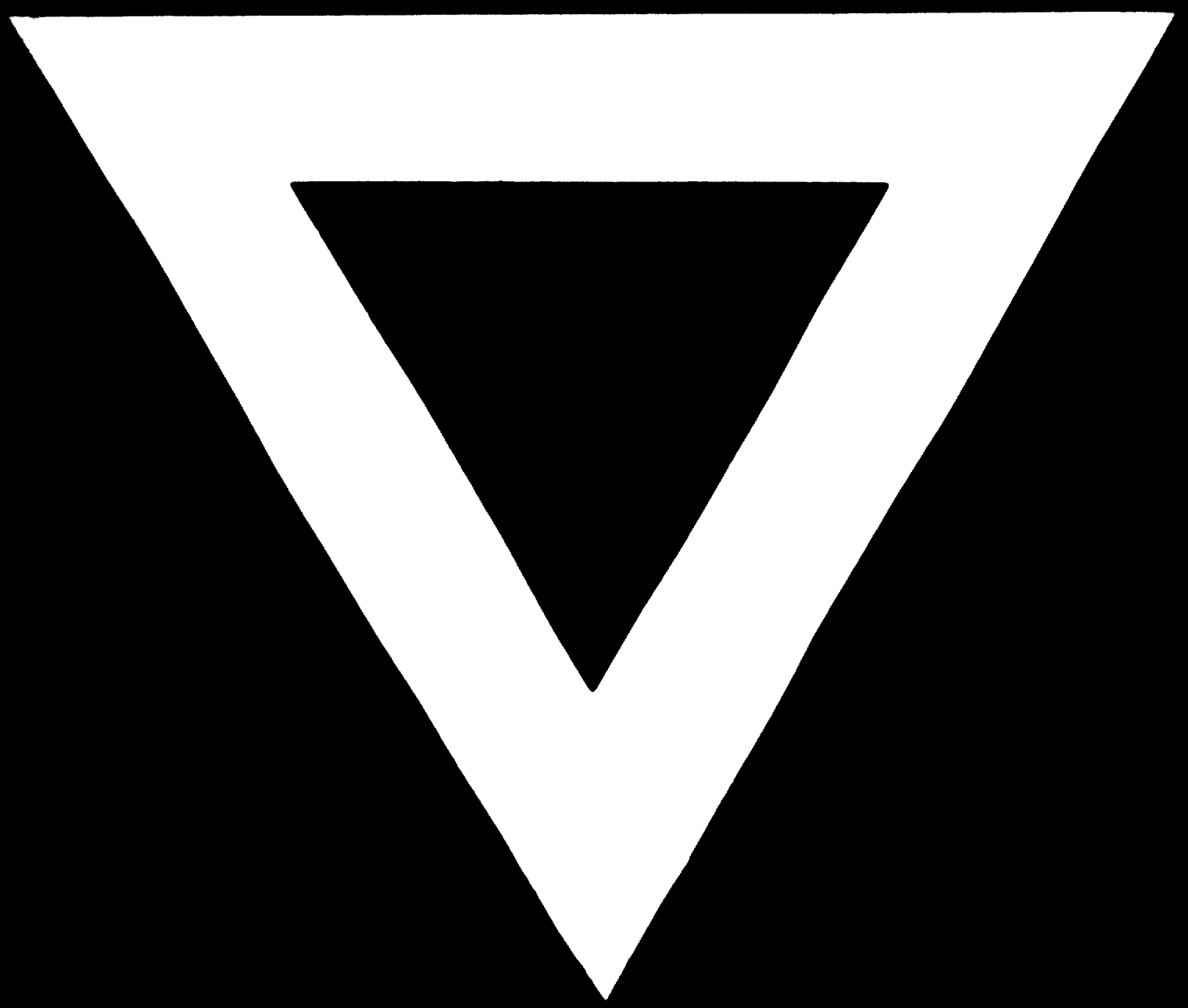
24. The plant design and engineering was taken up in 1958 and the plants erected and ready for operation by the end of 1961 before the ammonia plant was ready. Trial runs were instituted by middle 1962 and operation established by the end of the year. The guarantee tests were carried out in 1962 and all guarantees demonstrated. It is significant to note that another series of guarantee tests were carried out for the customer's satisfaction five years later in 1967 and proved all over again.

25. This does go to show that, given an opportunity and the essential requirement that such an organisation should be part and parcel of the industry itself, this type of challenge can be accepted

and its fulfilment with the full encouragement of the management has been the forerunner of rapid development in the design engineering field by the Fertiliser Corporation of India with its own know-how.

26. I have illustrated with two examples only and not dealt with in detail about many other activities and developments on account of limitations of time on the one hand and, on the other, a feeling on my part that it would be better to present a picture of the evolution of the organisation in two important areas - one -R&D and the other - engineering. Today, the organisation covers the entire gamut of activity towards development of a self-sufficient technological base in the fertiliser industry in all aspects, whether it be plant trouble-shooting, planning for the industry, building new plants on its own know-how, effecting import substitution measures by developing products from indigenous sources, vigorously contributing to the development of the industry on a basis of indigenous self-sufficiency in various areas such as basic feedstocks, technology and engineering, procurement and fabrication, installation and commissioning. Such efforts have also been taken up by the other public

sector fertiliser company in Kerala where also such work has been instituted. On the overall, while we can look back upon the structure that has been built and the contributions it has been able to make with a certain amount of pride and pleasure we are at the same time deeply aware that much more work remains to be done and, with the foundation already laid, steady progress should be possible.



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