Through : Mr. R.W. Beckman
Office - Director TDE

PDWAX325

The Industrial Credit & Investment Corporation of India Limited

Regd. Office:
163, Backbay Reclamation,
Bombay-400 020.

Tel.: Management 2025115
Gen. Office: 2022535
Grams: CREDCORP Bombay
Telex: 11 3062 ICIC IN
Fax: 2046582

PACER/ 0077

April 17, 1990

Dr. David J. Jhirad
Senior Energy Advisor
c/o United States Agency for International
Development
American Embassy
New Delhi 110 021

Dear Dr. Jhirad :

Eighth Meeting of the
Peer Review Committee for PACER

The Eighth Meeting of Peer Review Committee (PRC) will be held on Monday, April 23, 1990 at 10 a.m. at the Department of Non-Conventional Energy Sources (DNES), CGO Complex, Block No. 14, Lodi Road, New Delhi 110 003 to consider the agenda enclosed.

We request you to attend the meeting as an observer and join us for lunch thereafter. Kindly confirm your convenience.

With regards,

Yours sincerely,

P. H. Vaidya
Manager
PACER SECRETARIAT

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

EIGHTH MEETING OF PEER REVIEW COMMITTEE (PRC) ON APRIL 23, 1990 AT 10.00 A.M. IN CONFERENCE ROOM, DNES, NEW DELHI

A G E N D A

1. To confirm the minutes of the seventh Meeting of Peer Review Committee (PRC) held on February 13, 1990.

2. To consider Consortium Proposals for finanical assistance.

3. To note progress on formulation of proposal for solicitation.

4. To note the status of proposals under formulation and take a view on these proposals.

5. Any other item(s) with the permission of the chair.

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH
(PACER)

8th PRC Meeting

April 23, 1990

Confidential

Agenda Item 1

Minutes of the Seventh Meeting of PRC
held on February 13, 1990

(Copy enclosed)

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

Minutes of the Seventh Meeting of Peer Review Committee (PRC) held on February 13, 1990 at DNES, New Delhi.

The Seventh Meeting of PRC was held at 10.00 am. on February 13, 1990 in the conference room of Department of Non Conventional Energy Sources (DNES), New Delhi under the chairmanship of Dr. J. Gururaja, Adviser, DNES.

The following members attended the meeting :

1)	Dr. J. Gururaja Adviser, DNES	-	Chairman
2)	Shri S. S. Betrabet	-	Member
3)	Shri V. Bakthavatsalam Managing Director, IREDA	-	Member
4)	Shri V. Raghuraman Director (FE) NPC	-	Member
5)	Shri L.R. Suri Secretary General NCPU	-	Member

Leave of absence was granted to Shri N.J. Jhaveri, Deputy Managing Director, ICICI and Dr. S.P. Sukhatme, Department of Mechanical Engineering, IIT, Bombay.

In addition Dr. P. H. Vaidya, Secretary PRC, shri B.A. Bhatt, Shri S.S. Tamhane, Shri V.M. Deodhar (PACER Secretariat, ICICI), Mr. R.W. Beckman, Director, Office of Technology Development & Enterprise (USAID), Shri J.R. Meena, P.S.O. and Shri G.L. Gupta Under Secretary (DNES) attended the meeting as invitees/observers.

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Dr. J. Gururaja welcomed the members and invitees to the Seventh Meeting of PRC. He emphasized at the outset the significance of detailed discussion on each proposal/issue. This would enable the PACER Secretariat to gain from the vast experience of the members who represent various disciplines of energy sector. He observed that if the PRC meeting venue at DNES, Delhi was inconvenient, probably it could be shifted to a more convenient place, say ICICI, Bombay. He also wondered whether the PRC composition needs to be further broadbased to achieve the above objective.

While appreciating the work and efforts of PACER Secretariat Dr. Gururaja observed that there is still a need to support their efforts with innovative ideas to keep up the dynamism and tempo of programme implementation. He felt that there was a need to review whether PACER is progressing as envisaged. He suggested that members of PRC may help the Secretariat develop new project ideas and formulate projects. In this regard he referred to an approach paper on project formulation under PACER placed on the agenda for the meeting and stressed the strategy envisaged by the Secretariat. He highlighted the need for soliciting proposals, identifying suitable partners/consortia and orchestrating them to work on the development projects.

Dr. Gururaja further observed that each idea should embody a set of objectives, broad work plan, desired outputs and budget. The expertise of PRC members and PACER Secretariat

should be made available to the consortia and guidance should be provided for proposal submission as well. He desired that by the end of 1990 one or two such cases be developed in a proactive manner so as to provide a model. Dr. Gururaja, while sharing his experience in energy policy decisions, felt that there was a need for well prepared techno-economic feasibility reports. He mentioned DNES' concern over projects which are shelved due to lack of proper assessment of feasibility and suggested that a few consultancy firms/experts in private sector may be provided grant to prepare some such techno-econonic feasibility reports so as to provide a model. Shri S.S. Betrabet agreeing with the suggesstion felt that such exercises could be entrusted to Technical Consultancy organisations promoted by All India Financial Institutions. Dr. Gururaja concurred.

Dr. Gururaja also suggessted that a resource group of competent experts be formed which could act as a thinktank to help generate project ideas and provide support to PACER Secretariat in examining the project proposals in detail before the review by PRC. In this regard he suggested the following mode of project formulation. First an idea paper may be prepared by the Secretariat based on which a quick pre-feasibility report would be made. After assesing the suitability and desirability of technology development a professional consultant may be hired to prepare a techno-economic feasibility report embodying all the actual details such as project size, location etc.

Thereafter the PACER Secretariat may go ahead with formulation of project through solicitation of request for proposal. Dr. P.H. Vaidya mentioned that PACER has initiated the financing of Techno-economic feasibility reports in a small way by sanctioning proposal of Nimbkar Agricultural Research Institute (NARI).

Shri L.R. Suri, expressed disappointment over the slow progress and eventual withdrawal of proposal on Development and demonstration of 30 MWe AFBC Boiler for power generation by BHEL. Dr. Vaidya informed that Ahmedabad Electricity Corporation (AEC), one of the co-sponsors, has withdrawn from the proposal. However, PACER Secretariat had a series of discussion with the main proposer BHEL and it has shown interest in an alternative proposal for retrofitting old boiler of the same capacity at a considerably lower cost. BHEL has yet to come back to PACER Secretariat in this regard as also on the issue of its acceptance of conditional grant under PACER. Shri L.R. Suri emphasised the importance of the project idea and offered to discuss the iss with BHEL and Coal India Ltd, so that the propcsal can be revived and progressed. The suggesstion was welcomed by members and Dr. Vaidya assured the PRC to follow up the idea with Shri Suri. Shri Suri also felt a need for a project in the area of coal gasification and reduction of NOx emission from thermal power plants. Dr. Gururaja pointed out that with increasing availability of natural gas, urgency on the front of coal gasification has receded.

Dr. Gururaja felt that before appraising the projects they may be referred to the technical experts at DNES and elsewhere. Dr. Vaidya mentioned that PACER Secretariat has established rapport with DNES and various agencies working in energy field and cited the example of Proposal on Co-generation plant based on rice straw from Punjab Agro Industries Corporation which was referred to Commdr. Narendra Singh, (Retd.), Adviser, DNES and placed before the Committee comments made by him on the proposal.

Shri V. Raghuraman expressed the need to identify suitable slots/dockets in the energy sector wherein PACER could comfortably fit in. In this connection, Dr. Gururaja cited examples of technology/equipment related to non-conventional sources of energy (eg. solar thermal water heater industry) which have not yet taken off. He indicated that problem areas could be defined and suitable PACER projects could be identified in this industry to make it viable without Government subsidy.

The Committee then proceeded to consider the agenda.

Agenda Item 1 : To confirm the mirutes of Sixth PRC meeting held on October 19, 1989.

The Minutes of the sixth meeting of PRC held on October 19, 1989 were confirmed and action taken by the Secretariat on various Points was noted.

Agenda Item 2 : To consider the consortium proposal for financial assistance.

a) Proposal from Gandhi & Associates (GA), Gujarat Energy Development Agency (GEDA) and IIT, Madras (IITM) for development of FRP blades for Large Sized Wind Electric Generators (WEG).

Before taking up the proposal for detailed discussion Dr. Gururaja briefed the members about the background and details of his visit to Gandhi & Associates. Dr. Vaidya mentioned that the proposal was developed by the Secretariat in a proactive manner.

Shri Prafull Gandhi, and Shri M.B. Punater - partners of GA, made presentation on activities of GA, its past experiences and the evolution of the proposal. Shri Gandhi requested the committee to consider the proposal for its full cost of Rs.40 lacs including market survey and promotional expenses. In this context, Dr. Vaidya briefed the PRC about the discussion PACER Secretariat had with GA where in it was proposed to restrict the cost of the project to Rs 32 lac representing the technology development efforts. Dr. N.G. Nair, FRP Research Centre, IITM presented the technical features of the proposed development. The proposers mentioned that the blades would suit the existing 55 KW WEGs.

Dr. Gururaja mentioned that DNES would be considering in future 200-300 KW as the size of WEGs for grid connection purposes and suggested the proposers to include large matching sized blades in the proposal to which the proposers agreed.

Dr. Gururaja also suggested that proposers should consider the option of pitch control in addition to stall/tip control adopted by them. He also suggested that proposers may explore various spoilers' designs. He further observed that IITM may study the operational data and experiences of Tuticorin, Gujarat and other wind farms which are available with DNES for incorporating them in design features in order to avoid failures.

Mr. R.W. Beckman enquired about the availability of Raw materials and the competitiveness of the FRP blades with the imported ones. The proposers clarified that all the raw materials are available in the country except large continuous strand mats required in case of vacuum bag moulding, which is imported. They further mentioned that price of one set of the proposed blades would be Rs 2.8 to 3 lacs as against that of imported set is Rs.3.75 lac thus giving GA a price advantage. Shri Raghuraman enquired about the expected life of proposed FRP blades, Dr. Nair while explaining various factors affecting the life, mentioned that with adequate provisions on design and construction, the blades could last for about 10 to 15 years.

Dr. Gururaja observed that the work content of the project was satisfactory, However, technical development may be backed up with market development. The user angle should be more clearly defined and incorporated. He suggested if GEDA as an end user, could assure certain market, albeit subject to GA meeting the quality/specifications. It was clarified by the proposers that BHEL has identified GA as prospective indigeneous manufacturer of FRP windmill blades.

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Dr. Vaidya briefed the committee about the discussions PACER Secretariat had with proposers in connection with additional project cost of Rs 8 lacs representing premarket survey, promotional and publicity expenses. He, while accepting the need for proper assessment and possible tie-up of market, suggested that the project must establish first the technical parameters and stabilise product quality after which PRC could consider providing additional funds required for market survey and development. The suggestion was accepted by the committee and it decided to recommend the proposal involving the estimated cost of Rs 32 lacs for approval of ERDAC on the terms and conditions mentioned in the note.

<u>Agenda Item 3</u> : <u>To consider the Research Project proposal for financial assistance</u>.

a) Proposal from Andhra University for Domestic Survey and estimation of export demand potential for equipment using renewable sources of energy.

Before taking up the proposal for discussion Shri V. Bakthavatsalam briefed the members about the background of the development of the proposal. IREDA, while assessing the energy scenario in the SAARC countries found a need for devices based on renewable sources of energy and it was felt that a study to assess exact demand potential for such devices in South East Asian countries to begin with was essential. Dr. Gururaja mentioned that the original proposal envisaged was an ambitious

exercise and it is now pruned down to a modest scale. Dr. Vaidya indicated that the proposal was revised in consultation with the proposers and IREDA so that the research project could be completed faster and would be of timely use to IREDA/DNES.

Prof. K.C. Reddy, Andhra University (AU) presented the essentials of the proposal and methodology proposed to be followed. Dr.Gururaja felt that a few more devices should be included in the scope of the study so as to make it more comprehensive. Shri V. Raghuraman expressed his reservations about expanding the scope of the project. He cited the example of promotion of Nutan Kerosene Stove in this regard and mentioned that its commercialisation did not materialise as envisaged. In view of this he suggested that appropriate strategy to tackle the problem of commercialisation should be identified by the proposer. Dr. Gururaja observed that Indian market for renewable energy devices was dependent mainly on Government programmes. This has led to limited commercialisation of renewable energy devices. He suggested that the proposed study should look at two groups of countries viz. SAARC countries and developing countries seperately and estimate the export potential with resepect to realities/possibilities existing in those countries.

Shri Bakthavatsalam stressed need for a proper insitutional framework/arrangement for establishing the linkages in marketing of the renewable energy devices. Dr. Gururaja suggested that Dr. T.K. Moulik, IIM, Ahmedabad should be included on the advisory panel in view of his relevant experience in the area.

Looking at the agricultural scenario in the SAARC countries the committee advised inclusion of plants for Briquetting of agro-residues as part of the proposed project. The proposers agreed with the suggestion. Dr. Gururaja and Shri V. Bakthavatsalam enquired if it was possible to complete the research project in about 12 months. Shri Raghuraman felt it would be too ambitious a target. The Committee agreed that the travel and out of pocket expenses incurred by Prof. K.C. Reddy while attending the meeting of PRC may be reimbursed.

The committee agreed with recommendation of the PACER Secretariat to provide a grant of Rs 9.00 lac to Andhra University to undertake research project on Domestic market survey and estimation of energy demand potential for equipment using renewable source of energy viz. improved cooking stoves (chulhas), solar cooker and heater, biogas systems and briquetting/pelletisation of agroresidues ; on the following main terms and conditions :

1. <u>Scope of the Research Project</u>:

The proposers (AU) would carry out the project and prepare a report incorporating following aspects :

i) Review of available literature/studies/reports to identify gaps in the area.

ii) Drawing up of plans, strategies and approach/methodologies at the first group meeting in consultation with advisory panel and concerned officials of Government Departments/Agencies.

iii) Examination of motives, strategies and attitudinal changes of key factors involved in the introduction and development of renewable sources of energy; development pattern of new energy systems, products, markets, knowhow and expertise; the role of social and institutional factors including governments in the promotion, distribution and use of renewable sources of energy and related equipment therefor.

iv) Collection and compilation of primary data as also secondary data relevant to India, Nepal, Sri Lanka and Thailand. Taking countrywise inventory of existing relevant technologies, availability of resources and adoptability of new technologies.

v) Processing of data, drawing up inferences with special reference to technological, commercial and sociopolitical aspects.

vi) Preparation of draft report which would bring out gaps and problem areas and also suggest plausible R&D projects to make the use of renewable sources of energy and equipment therefor, on a wider scale with necessary cost effectiveness/efficiency levels.

vii) Discussing the draft report at group meetings of project team, advisory panel and concerned officials of Government Departments/Agencies and finalising the report after incorporating suggestions/observations of the experts of the group meeting forum as also those of ICICI.

Final recommendations of the project report would include detailed plan of action to achieve the desired results indicated by findings of the study. AU would also identify consortium R&D project(s) alongwith proposed members of consortium.

2. Schedule of Assignment

AU would submit draft report after 12 months of commencement of the project. After incorporating suggestions made by ICICI, AU would provide final report within 2 months after receipt of comments from ICICI.

3. Copies of Report

AU would submit 10 copies each of draft report and the final report.

4. Assistance

ICICI would provide a grant of Rs 9 lacs to AU for undertaking the project and prepare the reports. AU would bear any increase in cost of the project.

5. Schedule of Payment

upto 50% of the total grant would be payable at the time of commencement of project.

upto 80% of the total grant would be payable on submission of draft report to the satisfaction of ICICI (interim disbursement may be considered based on the progress made by AU) and

balance grant would be payable on submission of final report to the satisfaction of ICICI.

6. <u>Reporting Requirement</u>

AU would provide quarterly progress reports to ICICI on the lines of the format to be given by ICICI.

7. In the event of AU not being able to complete the project or abandoni: it for any reason whatsoever, all the data collected by AU shall be handed over to ICICI.

8. (a) Any publication of data or other information derived from the work hereunder, or any publication related to the work, shall contain the following legend or its approved equivalent :

"The work on which this (Article/Publication) is based was supported by a grant from ICICI pursuant to the Agreement between ICICI and United States of America for Program for Acceleration of Commercial Energy Research. The views and information contained herein are those of the authors and not necessarily those of ICICI. ICICI assume no liability for the contents of this document by virtue of the support given."

(b) Should ICICI agree to AU making available copies of the Report to third parties at a price, the sale proceeds thereof would be shared between AU and ICICI on mutually agreed terms.

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Agenda Item 4 : To discuss the profiles of consortium projects received and take a preliminary view regarding their suitability for support.

No.	Proposal & proposers	Comments
4(a)	Development of an economical heat setting stenter machine for synthetic fabric. - Devrekha Industries - Manmade Textiles Research Association - Himson Group of Industries	PRC noted the discussion PACER Secretariat had with the proposers, BTRA and ATIRA and suggested that the proposal may be developed for consideration of PRC.
4(b)	Development of 1.5 KW Stirling engine with multifuel capability - Stirling Dynamics Pvt. Ltd - Murugappa Polytechnic - IIT Bombay & Madras	The main Proposer has the technological capability and product is innovative and needs to be promoted however the proposers' financial capabilities are limited. The proposal should therefore be developed in consultation with IREDA which is also considering a similar proposal and should be placed for the consideration of PRC in due course if found supportworthy.

Agenda Item 5 : To review the progress of projects under implementation.

The committee reviewed the progress of projects under implementation. It was suggested that the progress report format may be so designed that the targetted progress can be easily compared with actual performance. PACER Secretariat clarified that the quarterly progress report format is reviewed from time to time and appropriate modifications are made. Members expressed the need for closely monitoring the projects so as to achieve the goals envisaged at the time of formulation.

Agenda Item 6 : To discuss approach paper on project formulation and selective project ideas for developing Request For Proposals.

Dr. Gururaja observed that the approach paper was the result of interactions PACER Secretariat had with DNES and others. He requested PRC members to study the paper and forward their comments to PACER Secretariat.

The Committee agreed that the dialogue on various policies regarding project implementation would continue and noted the project ideas for solicitation of proposals selected by the PACER Secretariat in consultation with the Chairman of PRC and suggested further processing/data collecton on these ideas so that proposals could be formulated in due course.

Agenda Item 7 : To consider the proposal for sponsoring sixth National Power systems conference to be held in June 1990 at Bombay.

PRC agreed with the recommendation of PACER Secretariat to provide as a co-sponsor a grant of Rs 30,000 towards meeting a part of expenses for holding the sixth National Power Systems Conference to be held at Bombay from June 4 to June 7, 1990 subject to the following conditions :

1) A presentation on PACER would be made at the Conference.

2) 5 delegates nominated by PACER Secretariat would participate in the conference free of charge.

3) PACER Secretariat would receive programme booklet and proceedings of the Conference free of charge.

4) The souvenir to be brought out at the conference would indicate PACER as a co-sponsor of the conference.

The meeting concluded with a vote of thanks to the Chair.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

8th PRC Meeting

April 23, 1990

Confidential

Agenda Item 2

Consortium Proposals for financial assistance

	Proposal	Proposer(s)	Project cost (Rs lacs)	PACER Assistance (Rs lacs)
a)	Development and demonstration of an energy efficient heat setting stenter machine for synthetic fabrics	Devrekha Industries MANTRA Himson Group	20.00	10.00
b)	Development and demonstration of 2KW Stirling engines with multifuel capability	Stirling Dynamics (P) Limited Murugappa Polytechnic IIT, Madras	18.50	9.25

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INIDA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

8th PRC Meeting

April 23, 1990

Confidential

Agenda Item 2(a)

MEMORANDUM FROM PACER SECRETARIAT ON THE PROPOSAL OF DEVREKHA INDUSTRIES, MANMADE TEXTILE RESEARCH ASSOCIATION AND HIMSON GROUP OF INDUSTRIES

Project Title : Development and demonstration of an energy efficient heat setting stenter machine for synthetic fabrics.

Principal Proposer : Devrekha Industries

Project Cost : Rs. 20 lacs

Means of financing : (Rs in lacs)

Proposer's Contribution	
- Devrekha Industries	10.0
PACER Contribution	
- Conditional Grant	10.0
	20.0

Proposal

The consortium of Devrekha Industries (DI), Manmade Textiles Research Association (MANTRA) and Himson Group of Industries (Himson), all of them situated in and around Surat, proposes to develop and demonstrate an energy efficient heat-setting stenter machine for synthetic fabrics (for sari and dress

material). The proposed stenter machine would employ radiation heating in a compact multipass machine in place of a convective air heating in a conventional single pass horizontal large machine, specifically for heat setting function which requires temperatures ranging from 190 deg C to 210 deg C. It would also explore the possibility of adopting vertical orientation of stenter and compare it with horizontal design in terms of operational convenience and compactness. The proposed development aims at achieving energy savings to the tune of about 50% to 60% of the current consumption in case of heat setting in the existing design of stenters.

Project Schedule

Development Project : July 1990 - June 1992

Commercialisation : By December 1992

A. MEMBERS OF THE CONSORTIUM

Devrekha Industries (DI)
(Principal proposer/sponsor)

DI, a partnership firm set up in 1982, is a small scale industry engaged mainly in manufacture of textile machinery. It has developed and commercialised textile process/machines which include (i) Process to convert beam dyeing operation of synthetic textile fabric into closed circuit system, (ii) Economical beam dyeing machine (iii) Economical low liquor rapid jet dyeing machine. In all the three cases given above, DI has achieved material and energy consumption norms far better than those existing in conventional process/machines. The energy savings achieved as a result of the above developments range from 30% to 70% as compared to conventional methods. (Please refer to Annexure-I).

All the three innovations are successfully commercialised and are being used by textile processing houses mainly situated in and around Surat. It may be noted that at present a very large share of synthetic sari and dress materials manufactured in the country is made in powerloom industries and processing houses of Surat. There are about 200 processing houses around Surat mainly engaged in processing of polyester and nylon fabrics for sari and dress materials.

DI is managed by Devendra S. Naik, (age 40 yrs.) the Managing Partner. He is a technocrat with a diploma in mechanical engineering. Before starting his own business, he worked for Batliboi & Company at Surat, Harish Textile Engineering at Umargaon, Padmanabh Silk Mill at Navsari, Texprint Engineering at Bombay and S. Shah & Compamny at Surat in various capacities viz. Supervisor, Maintenance Engineer, Sales and Service Engineer for a period aggregating about 9 years.

After starting his business, Naik has been travelling extensively to attend various international exhibitions/symposia/ conferences held in North America. Western Europe and Japan primarily to keep himself abreast with modern practices and new technologies employed in textile machineries and processing. In recognition of his innovative successful developments mentioned earlier, he has received International Award (WIPO - world Intellectual property Organisation) from UNO in 1988, National Awards (NRDC) in 1988 and 1985, Hari Om Ashram award from ATIRA in 1986 and Indian Merchant Chambers Award in 1984.

DI's total income during the year 1988-89, was about Rs.73 lacs which is estimated to rise to about Rs 125 lacs in 1989-90. The cash accruals earned/estimated for the period are Rs.3 lacs and Rs. 12 lacs, respectively. The present gross block of DI is about Rs.11 lacs.

Man-Made Textile Research Association (MANTRA) (Co-sponsor)

MANTRA is a joint venture of decentralised man-made industry comprising power-loan units and processing houses of Surat, Government of India and Government of Gujarat. Its operational as also resource mobilisation links with the decentralised textile units are through five different co-operatives as follows :

- The Surat Art Silk Cloth Manufacturers Association, Surat
- The Surat Vankar Sahakari Sangh Limited, Surat
- The Sasme Co-operative Society Limited, Surat
- The Udhna Group Weavers Producers Co-operative Society Limited, Surat and
- The Surat Jilla Textile Processors Co-operative Association Limited.

A council of Management which is constituted of representatives of the above contributing organisations and of both Govt. of India and Government of Gujarat, manages the affairs of MANTRA.

MANTRA's day-to-day affairs are looked after by its Director, Dr.R.S. Gandhi who worked in textile industry for over 15 years. He has rich experience in consultancy services and research projects in MANTRA for another 15 years. His brief bio-data is appended.

The financial resources of MANTRA are mobilised from industry through contributions, membership subscription, fees for services as also by way of grants from Central Government and Government of Gujarat.

As on March 31, 1989, MANTRA's membership aggregated 511 comprising 42 patrons, 224 life members, 182 weaving units and 63 processing units as ordinary members. For the year 1988-89 its revenue expenditure was Rs.14 lacs and capital expenditure was about Rs. 39 lacs. the total expenditure of Rs.53 lacs was met by contribution, membership subscription and service fees aggregating Rs. 24 lacs from industry and the Government grant of Rs.33 lacs.

MANTRA is engaged in research activities in the man-made textiles relating to (a) import substitution/export promotion, (b) quality control/cost reduction, (c) energy conservation, and (d) pollution abatement. MANTRA also undertakes training/education of personnel and provides technical/testing service to industry for routine problems of the small scale textile units. MANTRA is approved by Department of Science and Technology. Ministry of Textiles subsidizes the R&D activities of MANTRA.

Himson Group of Industries (Himson)
(Co-sponsor as an end-user)

Himson is engaged in yarn processing, fabric manufacture, fabric processing and manufacture of textile machinery. Himson had been associated with DI and MANTRA in the past R&D activities. The group's annual turnover is about Rs.50 crores.

It is managed by S. H. Bachkaniwala, a technocrat with over 35 years experience (Biodata appended)

B. Statement of the Problem

After a fabric is woven, it undergoes extensive wet processing. Amongst various process steps involved, drying, finishing and heat setting constitute one of the most energy intensive process steps. At present, these functions are carried out in a hot air stenter machine employing convective heat transfer mode, the heating medium being hot air. The air is heated by hot thermic fluid which enters the stenter heat exchangers at around 280 deg C to 300 deg C. Thermic fluid heating system includes a heater which burns oil or coal, as also ground level sump tank, overhead expansion tank and distribution system involving piping and pumps.

Stenter's functions are normally in the order of drying, heat setting and finishing. Drying and finishing require temperature upto 150 deg C and heat setting would require 190 deg C to 210 deg C, depending on the variety of fibre. Thus, heat setting is one of the most energy intensive of the stenter operations.

During heat setting, in order to enhance the co-efficient of convective heat transfer, at times steam is also injected in the air stream. The system is required to bleed periodically to avoid build up of inflamable oil vapours as also to maintain moisture level in the stenter.

The heat losses associated with such convective heat transfer mode are significant as compared to actually useful heat required for heat setting. It is estimated that the energy losses are of the order of about 97%, of these major losses are on account of heat exhaust through air and injected steam (about

90%). Please refer to Annexure - 2. Recently, some of the heat setting functions seek to do away with steam injection. In such cases , while the heat exhaust losses in absolute terms reduce substantially, its corresponding percentage would be about 68%. Additionally the blowers consume electrical power throughout the heat setting process in either case, to ensure high turbulence for better convective heat transfer.

Besides, the stenter machines occupy the larges space amongst all machines in a textile processing house. Its operation, therefore requires attendance over a larger area which requires higher manpower.

For economical operations, the stenter functions are distributed among individual dedicated stenters. Accordingly, most of the processing houses carry out drying, heat setting and finishing in three different stenters. Some processing houses have two stenters with drying and finishing being carried out in one stenter and heat setting in the other.

The present proposal seeks to deal with the energy intensive process of heat setting by developing an economical stenter dedicated to heat setting, while employing radiation mode of heat transfer. Since, predrying arrangement before the fabric's entry into heat setting machine is envisaged, the stenter system would not require bleeding of its atmosphere, and also air blowing is rendered redundant.

The existing hot air stenter employed for heat setting have thus the following disadvantages :

- Very high heat losses in exhaust (90%)
- High electrical power consumption by blowers
- High incidence of mechanical break down and preventive maintenance
- Requirement of large floor space area
- Need for more attendants

Work done so far

A Preliminary drawing of stenter for the first phase of the project is prepared. Study of various aspects of the stenter design, operations and functions of its components is in progress. Procurement of second hand stenter to prepare a prototype is underway.

DI, MANTRA and Himson have arrived at an informal understanding whereby MANTRA would render need based technical assistance to the proposed project and Himson would provide support of its manufacturing/infrastructural facilities to conduct field trials.

C. Technical Proposal

The consortium of DI, MANTRA and Himson proposes to develop an economical compact stenter for heat setting (of synthetic fabrics) based on radiation mode of heat transfer. The stenter development would be carried out in three stages as follows :

Stage (i) : To try out proof of concept on a conventional horizontal orientation of stenter machine to arrive at dwell time of fabric with necessary modification

for radiation heat transfer mode. It would enable the proposers to decide and then optimise stenter design with respect to speed of various types of fabrics, time to achieve desired heat setting temperatures on fabrics as also stenter passes of fabric to achieve desired compactness. To carry out bulk trials to verify its reliability and efficacy with various fabrics.

Stage (ii) : After successful trials of the first stage on a horizontal stenter, the technology would be adapted to a compact design of vertical orientation of stenter.

Stage (iii): More suitable orientation of the two heat setting stenter machines would be installed at Himson's processing house for bulk trials with various fabrics and commercial demonstration.

The development project would have to address itself to the following problems as well -

- Achieving temperature uniformity on both sides of the fabric
- Optimum clearances between upper heating elements, fabric and lower heating elements.
- Ensuring safe operation in events of sudden power failure or other eventuality of breakdown resulting in stoppage of fabric movement through the stenter. This is proposed to be tackled by incorporating compressed air motor to move the fabric through the stenter. It is envisaged that the motor would be activated on stoppage of fabric movement, causing the fabric to move for an adequately safe length of cloth.

- Removal of oil/chemicals from the fabric before subjecting it to heat setting. While in case of polyester fabric it would not be necessary, in case of nylon fabric, it is proposed to be achieved by employing a suitable predryer which could be heated by steam/oil.

The main steps involved in the proposed development project are -

- Procurement of second hand horizontal stenter
- Modification of the stenter to provide for radiation heating elements/tube banks, in place of the conventional heat exchangers for air heating. The radiation tube banks would be provided over and under the fabric, unlike the heat exchangers normally installed on sides.
- Exploring different configuration of heating elements with respect to size, shape, material, surface characteristics and size of fabric passage.
- Optimising fabric speed/dwell time in relation to heating medium temperature.
- Pegging on optimum design of stenter with respect to number of fabric passes together with suitable instrumentation and controls and fail safe provisions.
- Carrying out trials on bulk fabrics of various types.
- Optimising compact design in horizontal orientation of stenter in relation to technoeconomic viability
- Exploring adaptation of the above technology in vertical orientation. If its technoeconomics permits, constructing a compact vertical stenter.
- Taking bulk trials of vertical stenter

D. IMPLEMENTATION PLAN

The proposed development project would be jointly undertaken by DI and MANTRA whereas Himson would participate in field trials and demonstration as an end-user. DI would develop and engineer the prototype and set-up the demonstration unit with technical guidance and assistance in technical

analysis/interpretation from MANTRA. Himson would provide facilities for shop floor field trials in its process house along with necessary support of infrastructure and material. The entire project would be managed and controlled by DI, both technically and financially. The proposed development project is expected to be completed by June 1992, with an implementation period of 2 years.

E. COST OF THE PROJECT

The cost of the proposed development project is estimated at Rs 20 lacs spread over the implementation period of 2 years as follows :

	Year I (Stage i)	Year II (Stage ii)	Total
Equipment	2.5	2.0	4.5
Salaries, wages & overheads	0.5	2.0	2.5
Materials, stores & consummables	1.0	10.0	11.0
Trials, general, admin. expenses	1.0	1.0	2.0
	5.0	15.0	20.0

Equipment cost provides for an old secondhand conventional stenter machine which would be modified for the radiation heat transfer mode under stage (i) mentioned earlier, non-contact type pyrometer, humidity meter and electrical panel with electronic accessories. It would include suitable controls and interfacing in respect of temperature indicator, thermic fluid valve, speed of fabric and fabric feeding arrangement.

The salaries and wages provide mainly for incidental labour and supervision cost. The materials cost is on account of carbon steel tubes for radiation heating elements/tube banks as also distribution headers for thermic fluid, stainless steel and mild steel sheet metal, insulation, clips for fabric etc. Suitable provision is made in respect of trial runs.

F. MEANS OF FINANCING

The estimated cost of Rs 20 lacs is proposed to be financed as fol.

	in lacs)
Proposers' contribution	
- DI	10.0
PACER contribution	
- Conditional Grant	10.0
	20.0

Proposers' Contribution

DI, the main proposer, would contribute 50% of the requirement of funds in form of partner's capital of Rs 10 lacs, to meet a part of the cost of the project. DI's operations are profitable and has satisfactory order book position. Therefore, its contribution would be brought in as per the implementation schedule.

Conditional Grant under PACER

The main proposers of the consortium R&D project have requested ICICI to provide conditional grant of Rs 10 lacs out of the funds available under PACER to meet a part of the cost of the

project. The conditional grant will be repayable on successful commercialisation of the project. Payment to PACER will be by way of a negotiated percentage of revenue arising from the project on commercialisation and limited to a maximum of 200% of the PRCER contribution towards the project cost.

G. **PROSPECTS**

Man made textile industry of Surat is engaged in processing of synthetic textiles made of nylon and polyester filament yarns. It is estimated that these process houses (over 150 in number) have aggregate capacity to process more than 1500 million metres of fabrics evey year. Each of the process houses would have stenter machines for drying, heat setting and finishing of the fabrics. As mentioned earlier while drying and finishing could be carried out at around the same levels of temperature (130 deg C to 150 deg C), the heat setting function is carried out at higher temperatures (190 deg C to 210 deg C) depending on type of fabric. Therefore, most of the processing houses carry out heat setting funcation in a seperate stenter exclusively, to achieve better operational economics. If a process house has 2 stenters, drying and finishing is done on the same stenter operating at lower temperatures and the other stenter is operated at a higher temperatures for heat setting. Some process houses have 3 stenters and each of the three functions is carried out in seperate individual stenters. Thus almost all processing houses with 2 or more stenters have an exclusive stenter for heat setting.

As indicated earlier, the proposed stenter with radiation heat transfer mode, is expected to achieve 50% to 60% energy savings which in monetary value would amount to Rs.7.8 lac/annum based on oil firing and Rs.3.8 lac/annum based on coal firing. (Annexure - 2). Besides, with multipass arrangement it would occupy less space as compared to the conventional stenters.

With the flourishing business of decentralised synthetic textile industry of Surat and the reputation earned by DI's existing range of products, it would be reasonable to expect encouraging prospects for the proposed stenter machine after successful development and demonstration of its commercial prototype.

H. BUSINESS PLAN

The commercial project for manufacturing proposed type of stenter machine would be undertaken by DI. It would alos do its marketing and after sales service. It is envisaged that while DI would have installed capacity to manufacture upto about 10 stenters/annum, initally DI would make 2 stenters in the first year and 3 stenters in the second year of commercial manufacture.

Once these stenters perform as expected, DI expects to receive more orders. It is assumed that it would manufacture 5 stenters in the third year, 7 stenters in the fourth year and 9 stenters from the fifth year (and onwards) of commercial production. At the rate of Rs.15 lacs/annhum, DI is expected to earn annual sales income of Rs.30 lacs, Rs.45 lacs, Rs. 75 lacs,

Rs.105 lacs and Rs.135 lacs respectively on account of the proposed stenter. DI's existing operations are profitable and is expected to continue to earn profits even after the commencement of the commercial production of the new stenter. Assuming payments to PACER @ 5% on sales (of the proposed stenters), the obligations in respect of the conditional grant are expected to be discharged during the first six years of commercial production.

I. STRATEGIC ANALYSIS

The proposed project has been analysed in terms of business attractiveness and consortium strength factors. The details of analysis are provided in Annexure - 3. It may be observed that the business attractiveness score is 37 points while the consortium fitness score is 41 points, out of the possible 60 points each. The aggregate score is thus at 78 points out of 120 points which is above cut off point at 70. The aggregate score indicates reasonable success potential for the proposed development project.

RECOMMENDATION

DI, a partnership firm in small scale sector, has developed and commercialised textile process/machines with substantial improvements in energy and material consumption norms, during the seven years of its operations. DIs Managing Partner D.S. Naik, a technocrat himself, has developed his three products successfully with informal consortium arrangement with MANTRA and Himson Group of industries.

The present proposal contemplates to employ radiation mode of heat transfer to replace convective mode of heat transfer in heat setting stenter machines. thereby it seeks to avoid or reduce the heat losses through air and steam in exhaust as also electricity consumption of air blowers. The proposal envisages savings in energy upto 50% to 60% of that required in a conventional hot-air stenter.

We recommend providing to Devrekha Industries (the proposers), a conditional grant of Rs.10 lacs to meet a part of the cost of the proposed development project out of funds available under the Program for Acceleration of Commercial Energy Research (PACER) on the following main terms and conditions

1. Before availing of the conditional grant, the proposers shall enter into a suitable Memorandum of Understanding specifying their mutual rights and obligations to the satisfaction of ICICI.

2. The proposers agree to make payments to ICICI of twice the amount of conditional grant disbursed

   (a) as a negotiated percentage of revenues arising from the project including job work on commercialisation and/or

   (b) by way of paying 50% of the revenue earned by selling prototype furnaces developed under the project.

3. a) Machinery or equipment purchased in whole or in part, with the conditional grant shall belong to the proposer but shall nonetheless be clearly identified and used only for the proposal purposes, unless ICICI otherwise permits in writing.

   b) The proposers shall not sell, give on lease, licence to conduct, mortgage, charge or otherwise dispose of the said machinery or equipment except with the prior permission in writing from ICICI.

4. The proposer shall bring in Rs 10 lacs by way of partners' capital/cash accruals/interest free unsecured loans to meet a part of the cost of the project in a manner and as per a schedule to be finalised in consultation with ICICI.

5. The proposers undertake to bring in additional funds in consultation with and in a form acceptable to ICICI to meet any shortfall that may arise in financing the project and/or other requirements.

6. The proposers shall utilise the conditional grant only in accordance with the Approved Proposal Budget to be finalised in consultation with ICICI.

7. The proposers agree to secure participation of Himson Group of Industries in the form of specific facilities and support required for carrying out the field trials and demonstration of the proposed heat setting stenter machine at their premises as indicated in the proposal.

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8. The proposers agree to appoint key persons for implementation of the project in consultation with ICICI.

9. ICICI and its authorised representatives reserve the right to carry out technical, financial and legal inspections during the implementation of the project.

10. The proposers shall keep ICICI informed about the progress of the project by submitting periodic reports in a form and substance to the satisfaction of ICICI.

APPENDIX

Bio-data of Dr. R.S. Gandhi

Name	Dr. R.S. Gandh
Qualifications:	B.Sc, B.Sc (Tech), M.Sc., Ph.D Awarded Hon. F.T.A. in 1985. Selected Fellow of Gujarat Science Academy in 1987.
Designation :	Director, MANTRA, Surat Dr. Gandhi served textile industry for over 15 years and has been working for the research association and rendering consultancy services for another 15 years. He has published a number of technical papers in Indian and foreign journals. He has been an editor of MANTRA Bulletin and has authored two books viz. "Man-made Textile Industry of Surat" and Instrumental Colour Measurements and Computer Aided Colour Matching for Textiles". Also he has been guiding students for their Ph. D. in South Gujarat University.

BIO-DATA OF SHRI S.H. BACHKANIWALA

Name — Surajram Hiralal Bachkaniwala

Qualifications : B. Text (University of Bombay, 1951) Awarded U.N. Scholarship in 1955 for "Special Studies on Synthetic Fibres and Textiles" and received training in manufacture and procesing of man-made textiles at Leeds University, U.K.

Under his leadership, Himson Group has in last two decades diversified its activities in textiles, enginering and ceramics with indigenous and foreign know-how.

He was one of the pioneers to moot the idea of cooperative marketing of textiles in Surat, which eventually catalysed rapid growth of decentrailsed textile industry of Surat. Surat Textiles Market and MANTRA are the results of his incessasant interest and efforts in the marketing and technical areas of man-made textiles.

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Annexure - I

DEVREKHA INDUSTRIES

(i) Closed circuit in Beam Dyeing

A prototype was designed and preliminary trials made in March 1982. The first unit was commissioned in August 1982.

It involves an attachment to conventional beam dyeing machine which enables circulation of dye liquor in close circuit. It results in savings in thermal and electrical energy. While the total savings depends on the design of existing conventional beam dyeing machine, the pay back period for incremental investment in the attachment ranges from 2 to 4 months only. The attachment is patented and is known as "Devrekha Attachment".

For the above invention, DI won Hari Om Ashram Award through ATIRA in 1988, NRDC Award in 1985 and Indian Merchants Chamber Award in 1984.

(ii) Economical Beam Dyeing Machine

Encouraged by the success of closed circuit attachment, DI took up modification in conventional beam dyeing machine so as to reduce m/l ratio. The first modified unit was introduced in February 1985.

The modified unit envisaged m/l ratio of 1:5 to 1:7 as compared to that of 1:16 in the conventional design. Redesigning of the unit resulted in reduction of size and dimensions for the same output. Besides savings in space and materials of

construction, the Economical Beam Dyeing Machine achieved savings of 50% in thermal and 30% in electrical energy as also 50% savings in consumption of chemicals. It also improved productivity in terms of capital and labour employed. The present generation of the Economical Beam Dyeing Machine requires about 10 hp power as compared to 25 h.p. power required in the conventional design.

In the monetary terms the above savings aggregate at Rs.2.5 lac/annum per machine of standard capacity.

(iii) **Economical Jet Dyeing Machine**

DI manufactured first Jet Dyeing Machine of conventional type in September 1985. Later, its first economical design was developed in December 1986 based on square body which was improvised into round body in June 1987.

The economical design enables dyeing at m/l ratio of 1:1 on wet fabric basis and results in savings of 70% in thermal energy, 50% in electrical energy, 50% in consumption of chemicals, 5-10% in dyestuffs and 60% in space requirement.

The latest version of Economical Jet Dyeing Machine being sold by DI runs with only 10 h.p power as against 30-40 h.p. in conventional machines. Further development efforts are on to reduce the power requirement to 5 hp. Its steam consumption is

around 0.6 - 0.7 kg/kg of fabric dyed as against 2.5-3.0 kg/kg of fabric dyed for conventional machines. Attempts are afoot to further reduce the steam consumption. A standard Economical Jet Dyeing Machine enables savings of approximately Rs.4 lacs/annum in energy and colour/chemicals.

DI received International Award (World Intellectual Property Organisation - WIPO) from UNO and National Award from NRDC in 1988 for the development of Economical Jet Dyeing Machine.

Annexure - 2

DEVREKHA INDUSTRIES

Heat Balance Calculations and Potential of savings

As indicated in the 'Statement of Problem', a prearied fabric would enter the heat setting stenter machine. Accordingly heat balance of the conventional heat setting operation may be considered as follows :

Input, Mcal/hr

Steam	452	(A)
Thermic fluid	163	(B)
Cloth entry	3	(C)
Moisture in cloth at entry	Negligible	
Fresh air	19	(D)
TOTAL	637	

Output, Mcal/hr

Outgoing cloth	17	(E)
Evaporated Vapours in exhaust	10	(F)
Loss of injected steam in exhaust	452	(G)
Hot air in exhaust	125	(H)
Surface heat losses	25	(I)
Others	8	(J)
TOTAL	637	

Considering normal working load and conditions, the following assumptions would be valid.

Sp. Heat of cloth	-	0.4 to 0.5
Production rate	-	240 Kg/hr
Ambient temp.	-	30 deg C
Outward heat set fabric temp.	-	180 deg C

Theoretically One kg. of cloth would use heat = 1 x sp. heat x Temp. difference

= 1 x 0.4 x (180-30)

= 60 Kcal/kg

= 0.06 Mcal/kg

Actual Heat used by One kg cloth in M/c.

$$\frac{\text{(Heat content of cloth in)-(Heat content of cloth out) (Mcal/hr)}}{\text{Production. (kg/hr)}}$$

$$= \frac{E - C}{240}$$

$$= \frac{(17 - 3)}{240} \quad \frac{(\text{Mcal/hr})}{(\text{Kg/hr})}$$

= 0.0583 Mcal/kg

= 58.3 Kcal/kg

= 0.058 Mcal/kg

Conventional Stenter used Total Heat = 637 Mcal/hr (K)

Actual heat taken by the fabric for heat setting = E - C = 14 Mcal/hr (L) (2.19%) of the total heat employed.

Heat Exhaust by air/steam injected = G + H = 577 Mcal/hr (M) (90.5%) of the total heat employed

Other heat Losses = F + I + J

= 43 Mcal/hr (N)

(6.75%) of the total heat employed

Heat for process = L + N

= 14 + 43

= 57 Mcal/hr

Loss in Process = K - (L + N)

= 637 - (14 + 43)

Objective is to reduce losses upto 70%, that would be the energy savings. However, the scope of the present proposal envisages energy savings of 50% to 60%.

With the radiation mode of heat transfer the losses on account of (G) and (H) would be sought to be curbed, as far as possible in practice. The actual parameters would be arrived at during the implementation of the proposed development project.

Even if, 50% of the thermal energy losses are saved, it would result in savings @ 290 Mcal/hr. Considering on an average 20 hrs/day of Stenter operation, it would be equivalent to about 600 kg of oil savings per day. In monetary terms, the savings would amount to about Rs. 2,600/day at 50% savings in thermal energy losses on the basis of oil as the source of thermal energy. Taking 300 working days/annum, the annual savings in oil bill would amount to Rs.7.8 lac. If the proposed stenter's cost is taken at Rs.15 lac, the payback period for the same would be around 2 years.

On the basis of coal firing of thermic fluid heater, with average coal CV value of 4500 Kcal/kg, the annual savings would be about Rs.3.8 lac in the coal bill. Accordingly, the payback period, on the basis of coal firing, would be around 4 years.

Annexure - 3

Strategic Analysis

DEVREKHA INDUSTRIES

A. Business Attractiveness

1. Sales/Profit Potential

Projected sales and profitability estimates are based on market potential existing primarily on account of decentralised manmade textile industry flourishing in and around Surat with scores of processing houses, quick to adopt such measures as the ones which lend them competitive edge. 6/10

2. Growth Rate

The growth rate would depend upon the success of the first few pieces of equipment with significant savings in fuel bill. As in the case of earlier three developments of textile processing machineries by DI , initial production would be low which would build up after two years. 6/10

3. Competitor Analysis

At present no company in the country is manufacturing stenter machines with radiation heat transfer mode for heat setting function. DI would be the first commercial venture to make it. Other established stenter manufacturers could adopt the new design concept only after the unequivocal success of the proposed technology is widely accepted. 7/10

4. Opportunity to restructure the industry

In case of successful application of radiation heat transfer mode to heat setting of man-made textiles the same may be extended to other varieties of fabrics as well with suitable adaptations. 5/10

5. Risk Distribution

The propsed product development would find specific application to the function of fabric heat setting only. 5/10

6. Special Factors

Commercial manufacture of proposed stenter machines would not require any special infrastructure/facility. 8/10

Total business attractiveness 37/60

B. Consortium Strength (or Fit) Factors

1. Capital Requirement

Commercial manufacture of the proposed stenter machines would require nominally incremental capital cost which DI can raise comfortably. 8/10

2. Marketing Capability

DI has existing marketing/servicing set up adequate to meet demand arising from decentralised textile industry of Surat as is evident from its existing activity. 7/10

3. Manufacturing Capability

DI has existing fabrication shops with necessary equipment/infrastructure which may be further strengthened to accommodate higher level of production during later years. 7/10

4. Technology Base

DI's track record in development and commercialisation of new technology/product is sufficient testimony to the technology base. 6/10

5. Raw Material

All materials and components required in the proposed manufacture are readily available indigenously. 7/10

6. Skills Availability

DI , MANTRA and Himson would have necessary technical and managerial skills. 6/10

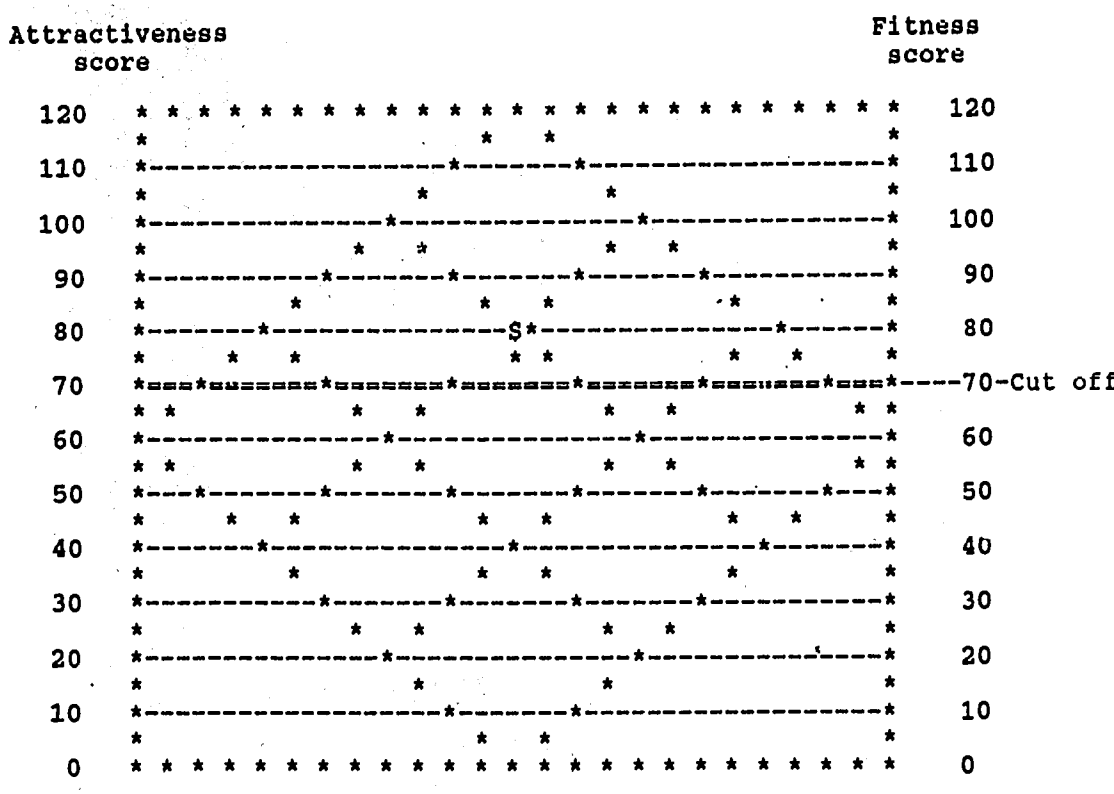
Total consortium fit score 41/60

The aggregate score of 78 is shown on the identity chart attached herewith. It indicates fair probability of commercial success.

ANNEX 3 (Contd.)
(Ref. Page 15)

DEVREKHA INDUSTRIES

IDENTITY CHART



A.Business Attractiveness	Pts	B.Consortium Fit	Pts
1.Sales/profit potential	6	1.Capital needs	8
2.Growth rate	6	2.Marketing strength	7
3.Competitor analysis	7	3.Manufacturing strength	7
4.Industry restructure	5	4.Technology base	6
5.Risk distribution	5	5.Raw materials availability	7
6.Specific factors	8	6.Skills availability	6
	37*		41*
		Total score	78

* Out of a total of 60 possible points.

@ Out of aggregate of 120 possible points

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH
(PACER)

8th PRC Meeting

April 23, 1990

Confidential

Agenda Item 2(b)

MEMORANDUM FROM PACER SECRETARIAT
ON THE PROPOSAL OF
STIRLING DYNAMICS PRIVATE LTD.
MURUGAPPA POLYTECHNIC
IIT, MADRAS

Project Title	:	Development and demonstration of 2 KW capacity Stirling Engines based on kerosene/petrol (urban sector) and biomass/agrowastes (rural sector).
Principal Sponsor	:	Stirling Dynamics Private Limited Vanagaram Road, Maduravoyal P.O. Madras 602 102
Project Cost	:	Rs 18.50 lac
Means of Financing	:	

	(Rs lac)
Proposer's contribution - Stirling Dynamics Pvt. Ltd.	9.25
PACER contribution - Conditional Grant	9.25
	18.50

Project Summary :

The consortium comprising Stirling Dynamics Pvt. Ltd. (SDPL), Murugappa Polytechnic (MP), and IIT, Madras (IITM) proposes to undertake project on development of 2 KW externally fired, compressed air operated stirling engines (SE) based on multiple fuels. These engines would cater to two different market segments. In the urban market, it would provide

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auxiliary source of power supply as alternative to portable gensets and in rural sector it would assist in multiple uses such as irrigation pumping and various agricultural processing activities. It is proposed to develop a prototype of Stirling Engine which could be brought on load quickly, would be compact, require less maintenance and would be cost-competitive alongwith different types of combustors. Proposers would modify available versions of plunger pumps and alternators for rural and urban applications respectively to suit the stirling engines and demonstrate their use at actual user's site. The powerpacks would be supported by systems for control of temperature, pressure and speed of engine.

Project Schedule :

Development project	:	Jyly 1990-September 1991 (15 months)
Commercialisation activities	:	October 1991 onwards

At the Seventh PRC meeting it was indicated that the proposed development is innovative and prima facie supportworthy. It was agreed that the main proposer has the technical capability to design the SE. However, in view of the financial and administrative constraints of SDPL, strengthening of consortium by inclusion of an organisation with established commercial capabilities was advised. Proposers while discussing with PACER Secretariat, agreed with the suggestions of PRC and indicated

willingness to include a company such as Thermax Ltd. which is a technology based organisation having established marketing capabilities in energy sector. IREDA is also considering assistance to SDPL out of funds allocated by European Commission, mainly for setting up commercial plant. In view of the above, PACER Secretariat had discussions with Thermax Ltd. when it was indicated that powerpacks of the proposed size of 2 KW would be out of its purview and it would be only interested in sizes above 50 KW based on radiation heat from industrial furnaces. We now propose to have discussions with other companies* for the above purpose. We propose to stipulate a condition that the consortium would include an organisation which would strengthen the marketing, financial and administrative capabilities.

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* Such as Greaves Cotton, TVS Group, Voltas, Godrej & Boyce

A consortium consisting of Stirling Dynamics (P) Ltd., Murugappa Polytechnic and IIT, Madras (collectively refered as proposers) proposes to undertake a project on development and demonstration of 2 KW capacity stirling engines based on kerosene/petrol (urban sector) and biomass/agro-wastes (rural sector) at an estimated cost of Rs 18.5 lac. To meet a part of the cost of the project, the proposers have approached ICICI for a conditional grant of rs 9.25 lac out of funds available under Program for Aceleration of Commercial Energy Rsearch (PACER).

A. MEMBERS OF CONSORTIUM

Stirling Dynamics Private Ltd. (SDPL) (Main Proposer), a new company was set up in 1984 in collaboration with Stirling Inc., USA, who had developed an experimental model of stirling engine (SE). SDPL further developed and modified a 5 KW SE model (ST 5) and sold about 120 nos. of them for irrigation pumping sets to DNES. These pumps have been installed in scattered locations all over the country. Many of these pumps are inoperative mainly for want of familiarity/knowledge of operational or maintenance procedure at the user's end.

Kirloskar Cummins Ltd., who had indicated their willingness to associate themselves with SDPL in a substantial manner, withdrew their support even after having had association for over 2 years. As a result, the company suffered a major setback in financial, administrative and marketing areas.

At present, SDPL is engaged in the following business activities which rely heavily on strong technology base of the company.

(a) Engineering jobs involving designing, manufacturing and machining;

(b) Maintaining the 5 KW Stirling engines sold around the country under DNES scheme; and

(c) Indigenising high pressure (750 bar) water pump for metal cutting/cleansing.

The company commenced its business primarily with the objective of SE development and commercialisation thereof. Since the new technology could not be mature enough to enjoy adequate market patronage, its scale of production remained low.

During the eight months ended on March 31, 1989, its turnover was Rs 8.54 lac (previous year, Rs 27.57 lac) on which it incurred a cash loss of Rs 9.72 lac (Rs 24.10 lac). The heavy cash losses were on account of low levels of production and unremunerative price realisation on SEs. The total accumulated cash losses of Rs 50 lac were met maintly through increase in the share capital (Rs 28 lac) and accrued and overdue interest (Rs 19 lac).

To improve the financial working, the company has begun executing profitable job work related to designing, engineering and machining as mentioned earlier.. Tamilnadu Industrial Investment Corporation (TIIC) is preparing a rehabilitation package which recognises the need for promotion of the company's main activity viz. Stirling Engines.

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SDPL would inform TIIC about the development project and obtain clearance from them for use of conditional grant for project specific purpose only in case of sanction. Suitable condition in this regard is stipulated.

The company, has so far gained valuable experience in designing SEs. It has achieved commendable capability of productionising the SEs, and has identified the problem areas to be tackled in technology development and eventual commercialisation.

Murugappa Polytechnic (MP) (Co-Proposer) established in 1957 is a privately sponsored technical institution under the 'expansion of technical education' scheme in the Tamilnadu State. Located at Madras, the polytechnic is managed by A.M.M. Chariities Trust. MP is an autonomous academic institution offering degrees/ diplomas in civil, electrical, mechanical engineering and computer science based on its own syllabi. MP has established facilities such as library, video/audio/software library, workshops, production/training centre, automobile technology laboratory, high technology workshop etc. Besides it has evinced interest in the development of non-conventional energy sources through the centre for Development of Rural Technology. It has working installations of water pumping windmills, solar cookers, solar water heaters, solar farm/tea shop, solar water distillary, 5 hp stirling engine test rig etc.

MP proposes to undertake testing of the SE to be developed by SDPL at its test rig. It would assess the parameters such as efficiency of the combustors and engine with various fuel, mean time before replacement of major itesm, and effect on frequency of power supply. Based on the testing/evaluation, it would assist SDPL in modifications of the prototype.

Indian Institute of Technology, Madras (IITM) (Co-proposer), a well known technological institution established in 1959 offers Bachelor, post graduate and doctoral degrees in several disciplines of engineering. IITM has the status of a university. IITM has few advanced research centres and offers industrial consultancy services.

IITM would mainly help in design of the product from the market angle, designing the combustors, especially for direct firing of solid biomass, control systems engineering and other problems solving in metallurgy and other aspects of material science. Dr. B.V.A. Rao, Applied Mechanics Dept. who specialises in Condition Based Maintenance and Tribology fields would be associated with the project.

In addition, consortium would include a financially sound and technically strong organisation, SDPL with the help of PACER Secretariat, proposes to discuss the project with companies including Thermax Ltd., Asia Brown Boveri Ltd. Greaves Cotton. We propose to put a condition to that effect before the conditional grant could be availed of.

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Bio-data of key personnel working on the project is enclosed in Annex A.

B. STATEMENT OF THE PROBLEM

In India, while most of the urban centres have power supply, the reliability thereof in terms of continuous availability is poor, barring very few exceptions. Therefore, recent times have witnessed growing trend of installing small captive powerpacks based on Internal Combustion (IC) engines using petro/kerosene as fuels by small commercial setups as also comparatively affluent households in urban and rural sectors. The power requirement of such units is of the order of 1-2 KW. In the rural sector for water pumping for irrigation as also drinking purpose from deep wells/canals diesel sets upto 5 hp capacity are widely used.

The engines of the gensets upto 5 KW exhibit several drawbacks. The overall energy efficiency of these gensets is very poor (11%). The combustion being internal, is not complete, hence the exhaust of the gensets consisting of unburnt hydrocarbons, particulate matter and carbon monoxide poses a pollution hazard. It also leads to wastage of precious fuel. The noise of these engines is loud, hence the work atmosphere is greatly affected. The main drawback of these engines is that though they are available in a very compact form, they consist of more than 750 components and parts. This leads to a complexity in manufacturing as also the maintenance of the engine. Due to the small size of the piston cylinder, the reboring after the service life of the same is difficult/ruled out.

These factors coupled with the gap between demand and supply of electricity have led to the need for auxiliary power supply based on kerosene/petrol as fuels by small commercial set ups as also comparatively affluent households in urban and rural sectors and biomass/agricultural residues for rural sector. research is going on worldwide to (a) improve the performance/ design of I.C. engines and (b) to evolve viable alternatives thereto. as regards (a), the technology has reached more or less, a plateau and no further improvements apart from materials selection seem possible.

Externally fired engines operating with air as a working fluid have been known for the last two centuries. (However, the present versions have evolved from the models built by Robert Stirling. John Ericsson and some contemporaries in the earlier half of the nineteenth century.) A note on historical evolution of Stirling Engines (SEs) is enclosed in Annex B. SEs have certain advantages over IC engines.

(a) Due to the external firing of fuel, the combustion of the fuel is complete and extracts its full calorific value (cv);

(b) It also lends itself to any type of fuel/heat source;

(c) Due to very less number of components with simpler design, the maintenance is easy and it would have equal or even longer longer Mean Time Before Failure (MTBF).

Research on the SEs has been in progress for various applications. Automobiles using SE has been a major field.

However, SE is not suitable to be used in cars with the present level of technology due to non-quick startup and higher weight. Due to these reasons and development in IC and CI engines, the SE research was abandoned. It is only after the World War II that SE has been thought of as viable alternative for power generation.

SE as available today has various drawbacks mainly owing to (a) higher weight which is a disadvantage in mobility/portability and involves higher material cost, (b) improper designs of combsutor, (c) lack of efficient heat recovery system which leads to poor overall efficiency, (d) very slow start-up and (e) operations at lower pressure. All these shortcomings need to be removed before a commercially viable and techno-economically feasible alternative could be evolved.

Work done so far

SDPL has designed/developed and produced around 120 SEs with a capacity of 5 hp for irrigation pumping applications. These were supplied to various end users through DNES. It has helped establish the technical feasibility of SEs. SDPL has acquired and improved the technology and is now capable of prototyping different configurations of SEs. The production experience has enabled SDPL to analyse various market segments and their respective needs. Based on this experience, SDPL has built a crude laboratory model of SE which has demonstrated the viability of the new, compact configuration. The officers from PACER Secretariat visited SDPL's workshop and witnessed the operations of this model with 0.6 KW power output.

C. TECHNICAL PROPOSAL

SDPL, MP and IITM jointly propose to design, develop and construct 6 prototypes of Stirling Engines of 2 KW nominal capacity. This design would be compact, twin cylinder and with a vee configuration. These would be capable of providing 2 KW mechanical power output and when connected to an alternator would generate 1.5 KW of electric pwer. The engines would be developed mainly for two market segments :

(a) Urban Market : These would provide an auxiliary source of power which would be operated in case of failure of grid supply. Here the SEs would be based on kerosene/petrol/LPG as fuel and coupled with alternator for generating A.C./D.C. power.

(b) Rural Market : These would be used for various operations including water pumping from deep wells and agricultural processing. In the demonstration, the SEs would be coupled with specially designed plunger pumps suitable for lifting water from depths below 30 m. systems for another end user/agro operations such as thrashing, cutting, etc. could later on be designed and demonstrated. These SEs would be based on mainly LDO/biomass/agricultural residues as fuel.

The project would involve -

(a) Designing and developing a new type of configuration of a compact size (SE). This would lead to deciding the selection of materials for crankshaft, cylinders, piston and various subcomponents. The engine would have compressed air (upto 10 bar) as working fluid and specially designed heat exchanger.

59x

(b) Designing and constructing easy to use and maintain combustors suitable for various fuels viz. (i) solid fuels like rice husk/straw, plant leaves/twigs and various agricultural residues and (ii) liquid/gaseous fuels like kerosene, petrol, LDO, LPG, biogas and producer gas. The main airm here is toenable quick start, amenability to changes in load and stability in operations.

(c) Designing suitable end use application systems based on modifications/adaptations of alternators and pumps available in market and finalising the specifications so as to facilitate sub-contracting their production for commercial operation.

(d) Designing and developing cost effective control systems for monitoring/controlling the critical parameters such as temperature of source, pressure of working fluid, speed of the S.E., frequency of power generated etc.

(e) Assembling of 6 prototypes for various purposes, testing of these and installation/demonstration at actual users' site.

It is proposed to design combustors with 70-80% efficiency and an engine with 20% efficiency. These would result in an overall efficiency of 16%. Typically, a 2 KW mechanical output SE would consume 1 lit/hr. of Kerosene (as against this portable gensets -of equivalent capacity consume 1.4 lit/hr.) and be capable of running upto 24 hrs. at a stretch. The proposed SE would be capable of starting in less than a minute while operating on kerosene/petrol as fuel. It is

proposed to design engine speed control system based on (a) governors and (b) pressure relief valves to ensure the power supply at 50 Hz. It would also have a fuel cut off device in the absence of flame and automatic fuel consumption control device. The SE would have a potential life of atleast 10,000 hrs. and a mean time before major repairs is expected to be about 2000 hrs. It is also proposed to design at a later stage co-generation systems based on the cooling water and exhaust heat which would enable generation of hot water at about 80 deg.C. for specific users.

The main stages in development of syst ems and powerpacks based on SEs are as follows :

(a) Design finalisation for the prototypes in all espects. In the beginning, the configuration as detailed in schematic diagram in Annex B would be considered which would be suitably modified.

(b) Mechanical design of major engine components and sub-assemblies and finalise their specifications.

(c) Design of control system and other support system.

(d) Construction of 6 prototypes and assembly.

(e) Endurance tests and simultaneous performance evaluation by independent agencies.

(f) Field trials of atleast 2 prototypes at actual users.

(g) Refinements and modifications based on the analysis of field data and retesting of modified versions.

6/x

(h) Finalisation of specification with regard to materials, mechanical drawings, tolerances, production processes, inspection procedure and design of jigs, fixtures, tools, dies and patterns.

(i) Productionising and test marketing.

D. **IMPLEMENTATION PLAN**

As SDPL has acquired a capability in designing SEs, it proposes to take up the responsibility of all the technology development in the proposed project. SDPL would co-ordinate the implementation of the project. It would associate in finalising productionising arrangements and standardising the final product and help in marketing them.

MP, being an academic institution having well equipped high technology laboratories, would assist in testing of the SEs in laboratory and on the field. MP would assist in design of speed control system. MP would suggest modifications in the SEs based on the performance and endurance trials.

IIT, Madras would lend support for finalising the product design which would help increasing the acceptance in both rural and urban sectors of market.

MP and IITM would also assist SDPL in design of combustor for direct firing of solid biomass, control systems engineering and solving problems in materials selection, manufacturing process etc.

The bar chart indicating implementation plan is enclosed in Annex C. The project would be completed in 15 months. Fourteen persons including engineers (3), Draftsmen (2), skilled technicians (6) and support staff (3) would be working on the project at SDPL.

E. COST OF THE PROJECT

The cost of the proposed project is estimated at Rs 18.50 lac as follows :

(Rs lac)

	Year 1	Year 2 (3 months)	Total
Equipment	4.00	1.00	5.00
Materials, stores & consummables	1.20	0.30	1.50
Salaries & wages	4.00	1.00	5.00
Travel	0.75	-	0.75
Data processing & consultancy	3.00	1.00	4.00
General & Administrative	1.00	0.65	1.65
Others	0.60	-	0.60
	14.55	3.95	18.50

Equipment include various dies, jigs, fixtures, tools, patterns and moulds, technical information books and papers.

Salaries and wages are for SDPL manpower as detailed in the implementation plan.

Data processing and consultancy charges include software design charges for engine design and external consultants charges.

63.x

General and administrative expenses include charges for freight, transportation, communication and field testing.

Others include labour contracts and miscellaneous charges.

F. FINANCIAL PLAN

The cost of the proposed development project estimated at Rs.18.5 lac is proposed to be financed as follows :

	(Rs in lac)
Proposers' contribution - SDPL	9.25
Conditional grant under PACER	9.25
	18.50

Contribution from SDPL :

Though SDPL has accumulated a cash loss of about Rs.50 lac it has taken corrective steps to improve working. SDPL has undertaken indigenisation of high pressure water pumps - (750 bar) for use in cutting, cleaning applications for M/s. TTG Machinery Manufacturing Co. Ltd. and proposes to manufacture these pumps which have attractive profit margins. SDPL also does speciality engineering jobs involving design, manufacturing and machining of import substitute items. These activities would help the company improve its operations. SDPL's contribution would be mainly in the form of services of its employees (Rs 5 lacs) who at present are underemployed. Balance requirement of Rs 4.25 lacs would be raised from relatives and friends who have agreed to provide funds specifically for the development project. We propose to obtain an undertaking from SDPL that TIIC or any other lending institution would not have any charge whatsoever on the assets to be created under the proposed development project.

Conditional Grant under PACER

It is proposed to provide a conditional grant of Rs.9.25 lac out of funds available under PACER. The conditional grant would be repayable after successful commercialisation of the products developed. Payments to PACER would be a negotiated percentage of revenue arising from the project on commercialisation of the stirling engines and limited a maximum of 200 percent of the PACER contribution towards the project cost.

65x

G. **PROSPECTS**

The market for portable gensets of capacities upto 2 KW is increasing at a fast pace. It is estimated that the total demand for generating sets upto 2 KW would be in the range of 1,39,00 nos. in 1989-90. It was estimated that the growth rate of demand for Portable Gensets would grow at a rate of 15% every year. However, the two portable genset manufacturers have barely achieved 50% capacity utilisation in 5 years. The projected gap between demand and supply of power is expected to rise. The genset demand, however, does not consider the vast rural market mainly for water pumping and various agricultural processing operation. The SE would not replace the Portable Gensets and would take up a little share of market. As the gensets are commercially developed and lot of research effort has gone in product development to make it user friendly. In view of the experience of portable genset manufacturers in urban market, it is felt that concentration of rural market would lead to better prospects. The market forces demand that the SE has to have such features that makes its use most easy and satisfies the user's needs most effectively. SEs can be built in various configurations making possible their uses for several purposes other than power generation as well. Some of these have been illustrated below :

a) Use as Heat Pump : SE when operated reversely by means of electrical motor operates as an heat pump. The atmospheric heat is upgraded to about 90 deg.C temperature. After proper research, suitable products for grain, tea, coffee drying could be designed. The main advantage would be non-use of Chloro-fluoro Carbons.

66

b) Use for Refrigeration : The SE operated by electrical energy but not reversely (as in heat pump) can lead to cooling down of the head even to sub zero temperatues. This is based on the principle of adiabetic cooling where heat is pumped in the cooling water.

c) Use of Solar Energy : Research on SE in Japan is mostly concentrated on this aspect. As the heat source is external to the engine itself, use of solar energy is possible. Parabolic dish solar concentrators would be required where concentrations as high as 1000 times is achieved. This heat can be concentrated on or transferred through a heat pipe to the heating head. Thus, the operating cost would be practically nil. Similarly, use of radiation heat from industrial furnace could also be made.

d) Use in automobiles : Although the slow start feature is not desirable in automobiles, with the possibility of start up within a minute would lead to a better acceptability. The cars based on SEs would make most efficient use of fuel and would have less difficulties in negotiating slopes as they would not need change of gears (the RPM of SE would adjust with load).

Thus, with the ongoing research, the prospect for commercialisation of SE is bright.

H. BUSINESS PLAN

Based on projection of demand for generating sets of nominal capacity of 2 KW and size of proposed operations of the main proposers there would be no difficulty in marketing them. The stress would be on rural market where the portable gensets have not penetrated a great deal and the SEs with agrowastes would have more acceptability. The projections of profitability are based on a modest sale of 500 engines of 2 KW shaft power output in the beginning at an ex-factory price of Rs 16,000 each. The level of production would be raised over next few years. Estimates of profitability is enclosed in Annex D. The estimated cost of setting up production plant with an installed capacity of 6000 SEs p.a. is Rs 280 lac. In the beginning, SDPL proposes to manufacture the SEs itself and market them through reputed agencies. We would be stipulating a condition that an organisation which is strong in finance and marketing shall be included in the consortium, hence, the marketing would be eased. After a few years, it may decide to license the technology to others in India and abroad.

I. STRATEGIC ANALYSIS

The proposed technology development is likely to change the power genset market significantly although not so much in terms of market share but due to its expansion in the rural sector. The consortium to take up the development project is technologically sound and would be strengthened with a suitable oganisation to take up the commercialisation. The proposed project was analysed for success in commercialisation on two

types of factors viz. business attractiveness (score of 38 out of 60) and consortium fitness (score of 43 out of 60) totalling to 81 out of 120 indicating bright chances for success of the technology development in commercialisation. The analysis is presented in Annex E.

RECOMMENDATION

The technology of Stirling Engines is known for long and it is proposed to bring out powerpacks based on it. These being more efficient than I.C. engine based gensets, are attractive propositions for the urban user. The rural markets' response for the efficient, rugged irrigation pumps and agro processing application based on Stirling Engines is likely to be encouraging. The consortium is well geared to take up the challenge of designing, developing and testing. We propose to help SDPL identify a suitable organisation which would strengthen marketing capabilities of the consortium. We, therefore, recommend providing a conditional grant of Rs.9.25 lac to the consortium consisting of Stirling Dynamics (P) Ltd., Murugappa Polytechnic, and IIT, Madras and a suitable commercial organisation to meet a part of the cost of the proposed project out of funds available under Program for Acceleration of Commercial Energy Research on the following main terms and conditions :

1. An organisation which is sound financially and has a track record in successfully commercialising technological products/processes, which would be willing to enter into an agrreement for PACER assistance shall be inducted in the consortium.

2. Before availing of the conditional grant, the proposers shall enter -

   (a) enter into a Memorandum of Understanding specifying their mutual rights and obligations to the satisfaction of ICICI;

   (b) obtain from Tamilnadu Industrial Investment Corporation and working capital lenders their consent to the proposers undertaking the development project and

   (c) give an undertaking that Tamilnadu Industrial Investment Corporation or any other lending organisation or creditor shall not have any charge whatsoever on the assets to be created under the proposed R&D projects.

3. The proposer who commercialises the technology agrees to make payments to ICICI of 200 per cent of the conditional grant disbursed as a negotiated percentage of revenues arising from the commercialisation of the project.

4. (a) Land, machinery or equipment purchased in whole or in part with the conditional grant shall belong to the proposers but shall nonetheless be clearly identified and used only for the proposal purposes, unless ICICI otherwise permits in writing.

   (b) The proposers shall not sell, give or lease, licence to conduct, mortgage, charge or otherwise dispose of the said machinery or equipment except with the prior permission in writing from ICICI.

5. The main proposer shall bring in Rs.9.25 lacs to meet a part of the cost of the project in a meanner and schedule to be finalised in consultation with ICICI.

6. The proposers undertake to bring in additional funds in consultation with and in a form acceptrable to ICICI to meet any shortfall that may arise in fainancing the project and/or other requirements.

7. The proposers shall utilise the conditional grant only in accordance with the approved Proposal Budget to be finalised in consultation with ICICI.

8. The proposers agree to appoint key persons for implementation of the project in consultation with ICICI.

9. ICICI and its authorised representatives reserve the right to carry out technical, financial and legal inspecations during the implementation of the project.

10. The proposers shall keep ICICI informed about the progress of the project by submitting periodic reports in a form and substance to the satisfaction of ICICI.

Annex A
SDPL-MP-IITM

To be placed on the table.

Annex B
(Refer page)
SDPL-MP-IITM

A Note on Stirling Engines

A Stirling Engine (SE) is a mechanical device which operates on a closed regenerative thermodynamic cycle with cyclic compression and expansion of the working fluid at different temperature levels. The flow is controlled by volume changes and there is a net conversion of heat to work or vice versa. SEs are often refered as hot-air/hot-gas engines.

A. Brief History

Although the first instances of the open cycle air engine go as far back as 1699 when an atmospheric fire-wheel was built in France, the truly working model of open cycle engine was built in 1807 by Sir George Kayly, an aeronautical engineer. Robert Stirling invented the closed cycle regenerative engine in 1816. Contemporaneously with Stirling, Swedish inventor John Ericsson introduced open-cyle regenerative air engine. All these developments faced limitations on the account of lack of suitable materials. The early engines were mostly used for driving ventilating fans and water pumps. In the mid-nineteenth century, the Internal Combustion (IC) engine was inveneted which was thoroughly researched world over. This, coupled with development of electric motor led to be SE being sidelined.

Phillips Research Laboratory (PRL) continued the research on SE and concentrated on miniaturisation achieved through very high working fluid pressures with an objective to provide a small, quiet, thermally activated electric power generator for

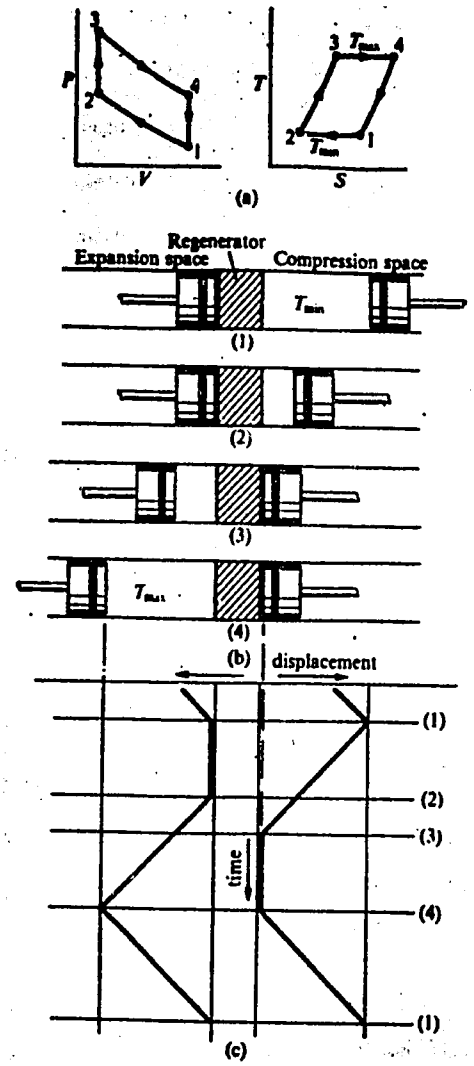
radios in areas where electric power was not available. PRL research led to the development of rhombic drive and roll-sock seal which resulted in single multiple cylinder SEs. Phillips granted licences of the technology to General Motors, Ford Motors, United Stirling AB Sweden and West German consortium of MAN and MWM. In 1977, US Department of Energy embarked on a seven year programme for development of automotive Stirling Engines (370-1480 KW) by allocating $ 180 M. The research on SE is going on worldwide with stress on solar energy especially in Japan. No commercial level product has yet come out so far.

B. Technical Details

As mentioned earlier, a Stirling Engine is a device operating on cyclic volume changes of the closed circuit working fluid. We describe below, first the ideal cycle viz. Stirling Cycle and then the practical cycle.

Stirling Cycle (SC), an idealised thermodynamic cycle is similar to the Carnot cycle. As illustrated in Figure 1, consider a cylinder containing two opposed pistons with a regenerator which is a packed wire-mesh which alternately releases and absorbs heat. One of the two volumes between the regenerator and the pistons is called expansion space and is maintained at a high temperature Tmax. The other is called compression space and maintained at low temperature Tmin. In the ideal cycle it is assumed that there is no thermal conduction in longitudinal direction, pistons move with friction and without any leakage loss of the working fluid. There are four processes in the cycle and are described with respect to Figure 1.

FIGURE 1



The Stirling cycle.
(a) P–V and T–S diagrams.
(b) Piston arrangement at the terminal points of the cyc
(c) Time-displacement diagram.

75X

Process 1-2 : The compression - space Piston which is at outer dead point moves to the inner dead point. The working fluid, all of which is in the cold compression space is compressed isothermally as heat Qc is abstracted from the cylinder to the surrounds.

Process 2-3 : Here, the compression space cylinder continues to move towards the inner dead point but the expansion cylinder starts moving to its outer dead point, as a result, keeping the volume constant. The working fluid passes through the regenerative matrix and heat transfer to the working takes place.

Process 3-4 : The expansion space cylinder continues to move to its outer-dead point, the other cylinder is steady. As a result of expansion, heat Qe is isothermally transferred from external heat sources at tmax to the working fluid.

Process 4-1 : In this phase, both pistons move, resulting in a constant volume but heat from the working fluid is trasferred to the regenerative matrix.

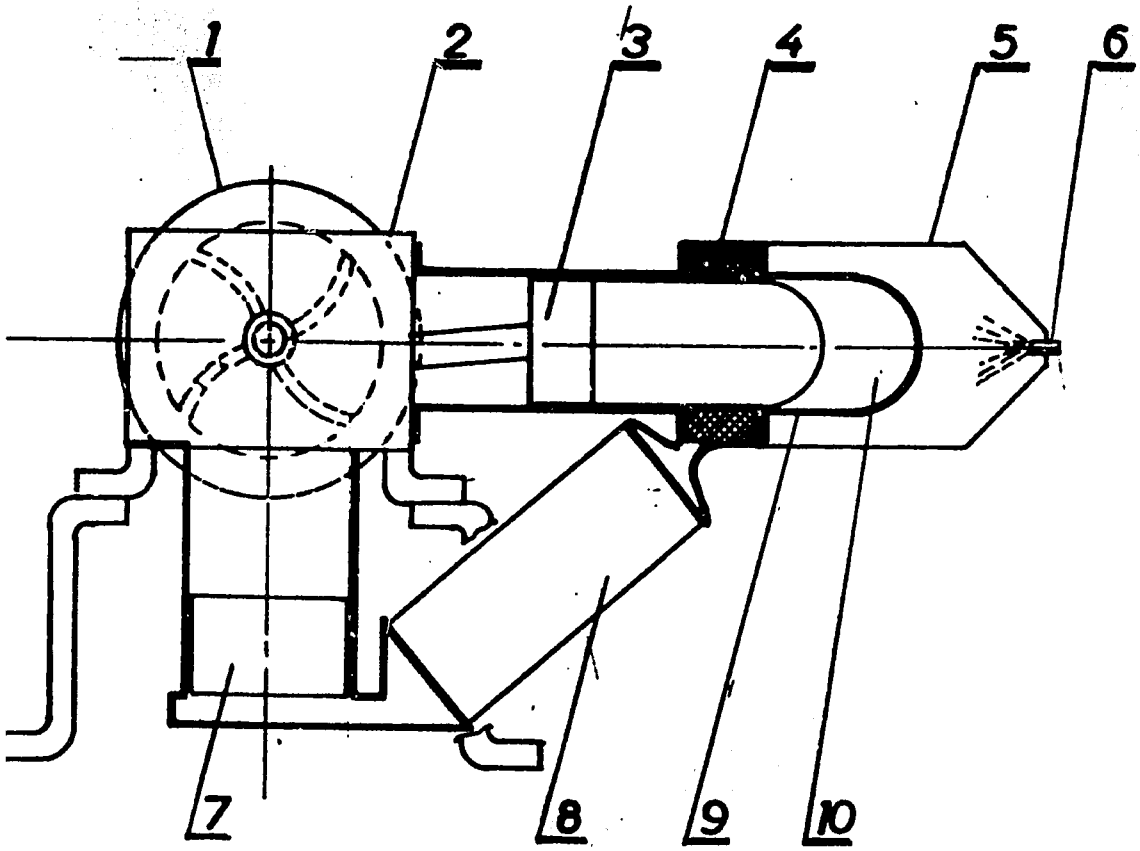
The Figure 1 describes the cycle on P-V and T-S diagrams. It is clear that if the temperature gradient Tmax-Tmin is kept high the efficiency would be high. Efficiency is defined as = (Tmax-Tmin)/Tmax.

Practical Cycle : The assumptions in the Ideal cycle as described above are not possible to be achieved in reality. In

16

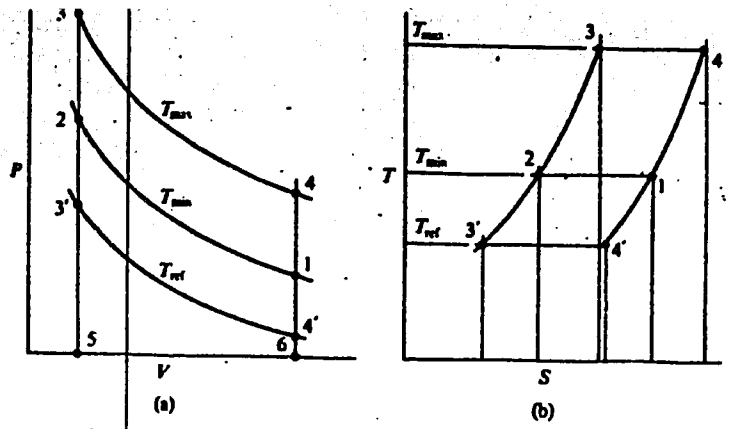
FIGURE 2

PROPOSED 2 K.W STIRLING ENGINE FOR DEVELOPMENT



1. FLY WHEEL
2. CRANKCASE
3. HOT PISTON
4. REGENERATOR
5. BURN
6. FUEL NOZZLE
7. COMPRESSION SPACE
8. COOLER HEAT EXCHANGER
9. HEATER HEAD
10. EXPANSION SPACE

FIGURE 3



Stirling cycle as prime mover and as cooling engine. In both prime movers and cooling engines the *compression* process occurs at temperature T_{min}. The *expansion* process occurs at a temperature of (a) T_{max} in the prime mover, and (b) T_{ref} in the cooling engine. Heat is supplied at a high temperature to produce useful work in the prime mover. Heat is abstracted to refrigerate in the cooling engine, and a net input of work is required.

addition, there are several mechanical and design disadvantages like dead space (i.e. volume of cylinders which is not swept by the pistons), imperfect heat transfer between the regenerative matrix and working fluid, heat losses from the body of the walls of cylinder etc. as a result, the relative efficiency defined as ratio of actual thermal efficiency ideal efficiency is substantially lower than 1. a value in excess of 0.4 is considered as well designed machine.

The SE design exhibits various mechanical difficulties such as materials availability/selection of dies. Various configurations of SEs are possible. SDPL, based on its experience of 5 hp SEs, has evolved a model which is based on two cylinders arranged perpendicularly. The proposed SE is as described in Figure 2. The benefit of this arrangement over the single cylinder arrangement is the compactness and the simplified alignment. The rating of the SE can be increased/decreased in an operating range by variations in the pressure of the working fluid. A SE with working fluid at atmospheric pressure capable of generating 1 KW power could give 2 KW power with the raised pressure of 7.5 bar.

C. <u>Other Uses of Stirling Engines</u>

(i) As Refrigerating Machines :

we describe this use with reference to the P-V and T-S diagrams (Figure 3). The SE for refrigeration application runs like in prime mover operation. The only difference being that the temperature of heat supplied from external source during

expansion is lower than the temperature at which heat is rejected from the same during compression. As described on the P-V diagram in Figure 3, the work of compression (Area 1-2-5-6) is the same as for prime-over mode. The work of expansion (Area 4'-3'-5-6) for refrigeration mode is less than the compression work and work equivalent to area 1-2-3'-4' from the external source is necessary to drive the cycle. During transfer from compression space to expansion space in process 2-3' the working fluid experiences a decrease in temperature and a corresponding increase during process 4'-1. The coefficient of performance (COP) is defined as the ratio of heat lifted to work done.

$$COP = Tref\ (Tmin-Tref)$$

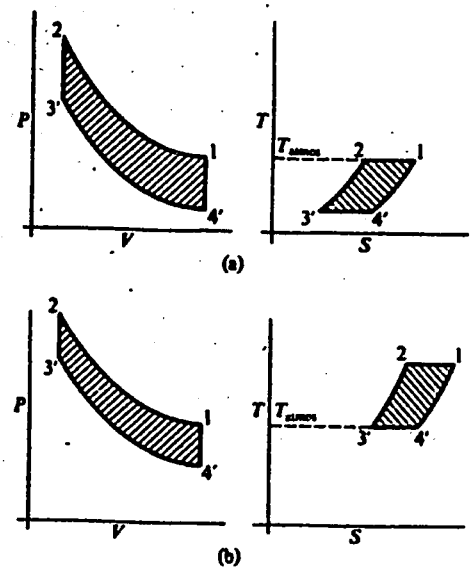
(ii) <u>Heat Pump</u> :

The SE in heat pump mode operates like the refrigeration mode, the only difference being both Tref and Tmin are increased. Unlike the other applications, in the heat pump mode, Tmin is the temperature at which heat is rejected from the system and is a useful product. Thus Tmin is above the ambient temperature and heat is supplied to the cycle at Tref. A comparison of refrigeration mode and heat pump made is given in Figure 4. In both the cases work from external source equivalent to area 1-2-3'-4' on the P-V diagram is essential to drive the cycle.

$$COP\ (heat\ pump) = heat\ rejected/work\ done$$
$$= Tmin/(Tmin-tref)$$

Reference : Stirling Engines
G. Walker, Clarendon Press (1980)

FIGURE 4



Stirling cycle as a heat pump and a refrigerating machine. (a) heat pump. (b) refrigerating machine. When operating as a heat pump or refrigerating machine, the expansion process occurs at a temperature less than that for the compression process, and a net input of work is required. In the heat pump, expansion is at atmospheric temperature, and the heat rejected during compression, at a high temperature, is the useful output of the cycle. In the refrigerating machine, the heat supplied, during expansion at a low temperature, is the useful refrigerating capacity of the cycle.

Annex C

(Ref. Page

SDPL-MP-IITM

Bar Chart

	Months				
	0 . .	3 . .	6 . .	9 . .	12 .
1) Finalization of design of systems components	<-->				
2) Manufacture of tools, dies & fixtures	<-->				
3) Component machining	<------>				
4) Assembly of first prototypes and testing at factory		<----->			
5) Finalisation of system components and auxiliaries			<-------->		
6) Testing of prototypes in different applications				<--->	
7) Analysis of data, system refinement				<--->	
8) Industrial system package design				<------>	
9) Manufacture/assembly of prototypes				<--------->	
10) Independent field testing, data analysis and modifications					<-------->
11) Finalisation of design/ drawings and projections for commercialisation					<--->
12) Report preparation					

Annex D

(Ref page

(SDPL-MP-IITM)

PROFITABILITY PROJECTIONS

Sales	1	2	3	4	5
Quantity	1000	2000	3000	4000	4000
Value	160.0	320.0	480.0	640.0	640.0
Materials, stores and consumables	78.0	153.0	225.0	288.0	288.0
Utilities	7.0	10.0	12.0	15.0	15.0
Salary & Wages	40.0	43.0	50.0	55.0	60.0
Repair & maintenance	7.0	9.0	12.0	15.0	15.0
Factory supplies	12.0	15.0	20.0	20.0	20.0
Royalty-PACER	1.6 (1%	3.2 (1%)	4.8 (1%)	8.9 (2%)	- -
Selling Expenses	15.0	20.0	25.0	30.0	30.0
Total cost	160.6	253.2	348.8	431.9	428.0
Profit before Interest and Depreciation	(0.6	66.8	131.2	208.1	212.0
Interest	29.0	31.0	30.3	28.8	30.0
Depreciation	48.2	33.2	22.6	16.0	11.4
Operating profit/ (loss)	(77.8	2.6	78.3	163.3	170.6
Net cash accruals	(29.6	35.8	100.9	179.3	182.0

Annex E
SDPL-MP-IITM

(Ref Page)

Strategic Analysis

The success of any R&D project on commercialisation is a very critical matter for the decision making by the top management. If a reasonable estimate of probability of commercial success of an innovative product is available before commiting large amount of funds on the R&D project, the decision making is greatly facilitated. This is possible to a certain extent by analysing certain factors pertaining to the proposed business itself and to the strength/fit of the consortium which would undertake the development. We discuss below 6 factors each from both these class of factors to assess the probability of commercial success.

	Score
A. Business Attractiveness Factors	
a) Sales/profit potential	
The product shows promise especially in rural market. It may take few years to enter the urban market.	7/10
b) Growth rate	
Market growth depends entirely on the initial acceptance which can be achieved with an agrasive marketing at least in the beginning	6/10

c) Competitor Analysis

The competition is mainly from portable gen-sets. However, as these have not yet entered rural market (which SEs have done) and the share of market sought is very little, competition is not expected to seriously affect the product. 7/10

d) Opportunity to Restructure

Presently the pumping and agricultural processing operations are done mainly by grid supply. Therefore there would be a great scope for restructure of the industry. 6/10

e) Risk distribution

The proposers have concentrated on rural market and on a few operation required in agriculture. However, urban market option is existing and risk is relatively distributed. 5/10

f) Special factors

SEs would utilise non-conventional fuels and are expected to be energy efficient. They are, therefore, likely to receive subsidies and concessions. 7/10

Total Business Attractiveness 38/60

B. Consortium Strength/Fit Factors

a) Capital requirement/availability

Commercial project, though involving sizable capital need, would be taken by a strengthened consortium. However, such an organisation needs to be identified. 6/10

b) In house marketing capability

The organisation to be selected would have a well established marketing set up hence the marketing aspects would be eased. 6/10

c) In house manufacturing capability

SDPL has established itself even with a meagre capital availability and now possesses good capabilities in achieving quality of the production. 8/10

d) Strength of Technology Base

SDPL has acquired an ability of developing the SE with various designs. It has evolved the product and is the only company to have done so. 8/10

e) Raw materials availability

The stress is on indigeneous abundantly available and cheap raw materials. 8/10

f) <u>Skills availability</u>

SDPL has the essential technical background. The consortium would be strengthened by an organisation with administrative, financial and marketing skills.

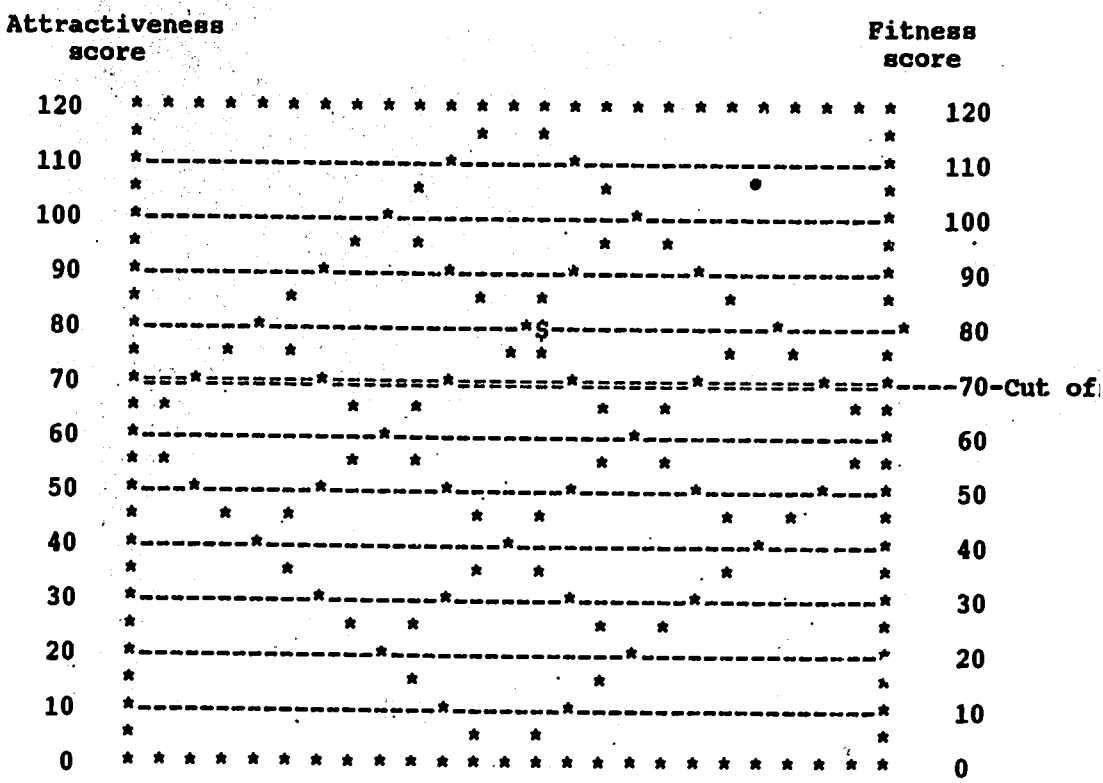
	7/10
Total consortium fit score	43/60
Total	81/120

The score of 81 is represented as $ on the identity chart in Annex E (contd) which indicates fair probability of commercial success.

ANNEX (Contd.)
(Ref. Page)

(SDPL-MP-IITM)

IDENTITY CHART



A.Business Attractiveness	Pts	B.Consortium Fit	Pts
1.Sales/profit potential	7	1.Capital needs	6
2.Growth rate	6	2.Marketing strength	6
3.Competitor analysis	7	3.Manufacturing strength	8
4.Industry restructure	6	4.Technology base	8
5.Risk distribution	5	5.Raw materials availability	8
6.Specific factors	7	6.Skills availability	7
	38*		43
		Total score	81

* Out of a total of 60 possible points.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

8th PRC Meeting

April 23, 1990

Confidential

Agenda Item 3

NOTE FROM PACER SECRETARIAT ON FORMULATION OF PROPOSAL FOR SOLICITATION

At its 7th meeting held on February 13, 1990, Peer Review Committee (PRC) noted the 'Approach Paper on Project Formulation' as also six project ideas for solicitation of proposals selected by the PACER Secretariat in consultation with the Chairman, PRC. The Committee suggested further processing/data collection on these ideas so that proposals could be formulated in due course. Accordingly, PACER Secretariat has initiated steps on various project ideas.

A brief note on project for development of AMORPHOUS METAL ALLOY CORE TRANSFORMER is enclosed.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

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NOTE ON FORMULATION OF PROPOSAL FOR SOLICITATION AMORPHOUS METAL ALLOY CORE TRANSFORMER

TECHNOLOGY - BRIEF DESCRIPTION

One of the major problems faced by the power sector in India relates to transmission and distribution (T&D) losses. The average T & D losses in Indian utilities during 1986-87 were estimated at 21.5%. Distribution transformers form an integral part of T&D system and reduction in core losses in transformers would result in conserving energy even though these losses may be a small percentage of total T&D losses. T&D losses particularly assume significance in rural electrification requires wide distribution network. By March 1989 about 78% of total number of villages were electrified and about 76,000 small distribution transformers (of upto 100 KVA size) were used for the purpose during 1988-89 alone. Thus there is enormous potential for saving energy by reducing core losses in transformers.

At present transformer cores are being manufactured from cold rolled grain oriented (CRGO) steel. Stacked cores are formed by using profiles stamped out of sheet metal on presses. Amorphous Metal Alloys (AMAs) now offer as new material for

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transformer cores because of their better magnetic properties. AMA Core Transformer (ACT) can reduce core loss by 70% compared to conventional CRGO core transformers. The initial investment in ACTs is expected to be about 30% higher than conventional transformers, however, the additional cost could be recovered within short span of time.

When Molten alloys are solidified rapidly (cooling rate - 1,000,000 deg c/sec) crystals cannot form and their atomic structures remain amorphous, like those of glass. The amorphous metal alloys are made by rapidly solidifying mixtures of iron, nickel, titanium, molybdenum or chromium with elements such as carbon, phosphorous, boron or silicon. The resulting materials have characteristics markedly different from those of their crystalline counterparts. Some amorphous alloys have low melting points teamed with high strength and hardness. Others offer ease of magnetization and relatively high resistivity. Still others combine easy magnetization with flexibility.

As structure of AMA is amorphous like that of glass the bonding force between the atoms is significantly less. Therefore it requires less energy for orienting them during magnetisation-demagnetisation cycles. This is the main principle behind reduction of core losses in ACTs.

AMA is manufactured in the form of thin ribbon of 0.025 mm thickness by melt spinning process. The material is extremely hard and is difficult to cut or shear. This property of material calls for special design of core and also special equipment for cutting and processing of core assembly.

The technology development for manufacture of ACTs has mainly two components as follows :

a) Development of process for manufacture of AMA material. This would involve development of various compositions of AMAs and processes to manufacture them.

b) Design, fabrication and testing of ACT.

It has been envisaged to pursue component 'b' at present. Component 'a' would require basic research work, large amount of resources and would involve long gestation period.

STATUS OF DEVELOPMENT OF TECHNOLOGY

At present AMAs are manufactured on commercial scale by Allied Metglas Products and Mark Metals,both from USA; Vacuum Smelzek, West Germany; and by a Japanese company. AMAs are commonly known in trade as Metallic glasses (Metglas) or 'Amo Metal' (Landed cost in Bombay is about Rs.100 per kg)

ACTs, at present are being manufactured by General Electric (GE), Westinghouse etc. Japan has also started producing such transformers.

Institutions/Organisations working on the subject (In India) :

In 70s Dr. (Prof.) T.R. Anantraman started research on rapidly solidified metals which he is continuing at Thapar Corporate R&D Centre, Patiala. However his effort is confined to developing various alloy compositions at laboratory level. Usha Amorphous Metals Ltd (UAML) has been recently promoted by Usha Rectifier, Delhi for manufacture of AMAs. To develop the market for AMAs, UAML has taken up development and promotion of ACTs on the forst phase of its market seeding programme. So far, it has attempted development of 25 KVA ACTs.

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Electrical Research and Development Association (ERDA), Baroda has developed a single phase 10 KVA distribution transformer with AMA core in co-operation with 2 local transformer manufacturers. The prototype transformer is presently being field tested by Gujarat Electricity Board. Corporate R&D Centre, BHEL has also developed a prototype ACT. Crompton Greaves Limited, Bombay has also initiated steps to develop ACT.

PROBLEMS TO BE TACKLED *

Problems to be tackled in the development of ACT can be categorised as follows :

1) Design constraints
2) Manufacturing/Production problems
3) Testing aspects
4) Repairs and maintenance aspects

1. **Design constraints** : The physical properties of AMAs such as high hardness, limitation on width of ribbon etc. mainly pose design problems. As the material is hard to cut or shear it is difficult to form laminations for core with conventional tooling. As a result the AMA transformer cores can have following configurations : a) cut core b) distributed gap core c) Torodial core and d) cruciform core. Of the above configurations distributed gap core has better properties. The design stage also has to take into consideration manufacturing, testing, maintenance problems.

* The discussion is restricted to design and fabrication of ACT from AMA Strip

2. **Problems involved in manufacture of ACT are as follows** :

a) Modification of process for manufacture to suit 3 phase distribution transformers

b) Selection of process for cutting AMA ribbon from various feasible alternative means such as i) graphite edge tool ii) high speed cutting wheel iii) plasma arc etc.

c) Absence of standards for jigs, fixtures, gauges toolings etc required for production

d) The conventional annealing ovens will not be suitable to carry out specialised annealing. The specialised annealing ovens required for namufacre of ACTs are not available presently.

3. **Testing aspects** : In order to compare core losses with those of conventional transformer accurate instruments will be required which could include equipment to analyse distorted wave farm. It may also be necessary to design suitable test methods for ACTs.

4. **Repairs and maintenance** : Data on these aspects is hardly available. Repair costs are expected to be on higher side as it would amount to reopening of core in order to replace defective coil.

Milestones to be achieved and parameters of poerformance to be aimed at:

Major milestones to be achieved include following :

1) Design of 100 KVA AMA core transformer

2) Design (Develop specifications) and manufacture/procurement of tooling, annealing oven, coil winding equipment etc.

3) Arrive at an appropriate economical processes for cutting AMA ribbon.

4) Develop techniques for forming core on mandrel, opening up of core, core lacing (forming of the distributed gap joint).

5) Develop appropriate method of testing.

Principal parameter of performance of ACT is core loss. The core loss in ACT should be aimed at 70% of that of a conventional transformer.

Alternative Routes :

ACTs can be manufactured from AMA ribbon (0.025 mm thickness) following the steps mentioned earlier. As the thickness of the ribbon is small it is difficult to handle this material. Process of forming core on mandrel induces stresses in the core which are to be relieved by annealing under magentic field. Annealing is a critical step in the manufacture of ACTs as the process has to be carried out as per the predetermined heating and cooling cycle. (Refer Annexure-B)

Alternatively one can start with bunched strips (0.13 mm thickness) which are supplied in the form of cut sheets according to the requirements of the transformer manufacturers. These strips can be used for manufacture of stacked core transformers. The process for manufacture of ACT is simplified by using bunched strips as annealing is avoided in this route. (Refer Annexure-C)

Estimated Cost:

Based on the discussion with the experts in the field the cost of development of AMA core transformer (starting from bunched strips) is expected to be about Rs 30 lac. The cost of equipment required for the project such as coil winding machine, coil cutting machine, annealing oven, testing equipment would be in the range of Rs. 7 to 10 lac. Expenses towards salaries, wages, materials etc would form remaining part of the cost of the project.

Potential Application Area:

During the year ended December 31, 1989 about 90,000 transformers of upto 250 KVA rating were produced. Considering that nearly one lac distribution transformers are added to the system every year, introduction of ACTs in the country will result in considerable saving of energy. About 2-3% of the total electric energy consumed in rural areas goes to keep transformers energised. ACTs thus offer an appropriate solution for distribution programmes.

NOTE During the discussions with ERDA, Baroda and Usha Amorphous Metals Ltd. (UAML), New delhi for compiling information on the subject PACER Secretariat received indications about their interest in approaching PACER for development projects in the field. ERDA has also submitted a profile of project for development of ACT (63 KVA - 3 phase). (Refer Annexure-D)

This writeup is prepared by S.S. Tamhane based on visits and discussions with following : (Name of the persons contacted in bracket)

1. Electrical Research and Development Association, Baroda (Shri R.H. Buch, Director and Shri U.C. Trivedi, Sr. Engineer)

2. Usha Amorphous Metals Ltd. (Shri Mahesh Gidwani, General Manager (Projects)

3. Indian Institute of Technology, Bombay (Dr. P.K. Rao, Dr. A.R. Kulkarni, Dr. N. Vemkat Ramani)

4. Crompton Greaves Limited (Shri N. Naik, Design Engineer)

References : - Machine Design, April 1984

Annexure-A

PROCESS FOR MANUFACTURE OF ACT

Process for manufacture of AMA core transformer includes following steps :

i) Winding of core on mandrel from bulk reel. The tension in ribbon during winding is an important parameter.

ii) Cutting of core to form strips. The cutting can be done by graphite edge tool or high speed cutting wheel of green carborandum or even by plasma arc.

iii) Cut strips are picked up in samll bunches and are then wound around a dividable mandrel.

iv) Core is formed by driving a wedge between the 3 parts of madrel (ie by forming process) using forming pressure of about 10,000 kgf.

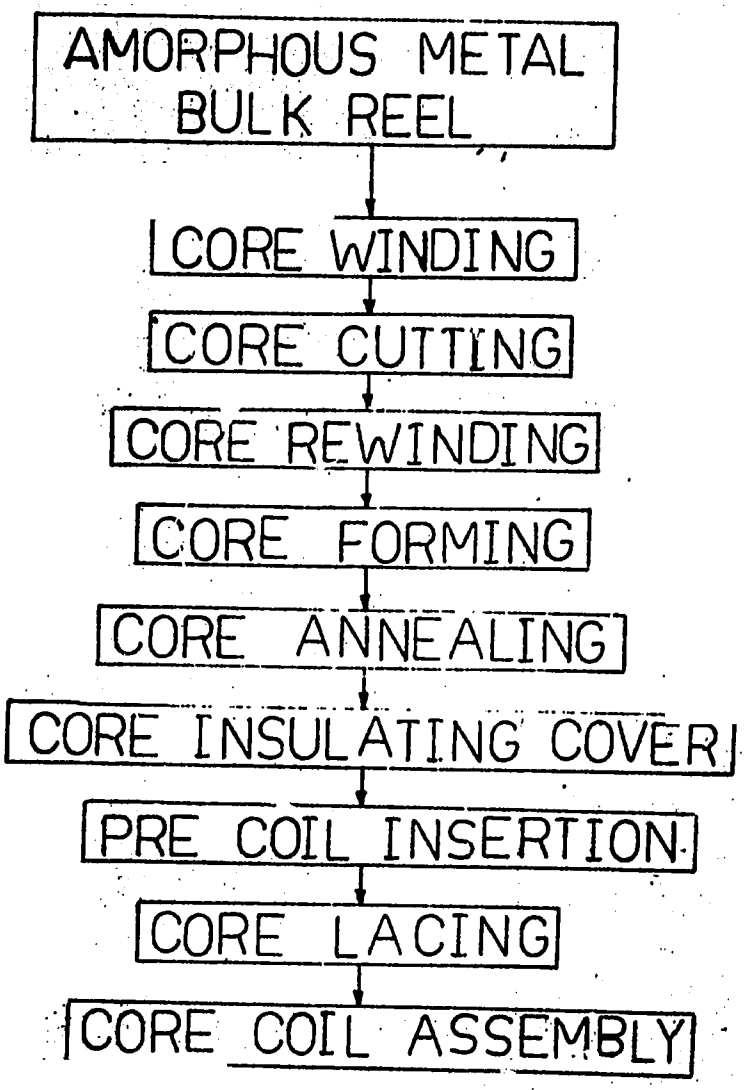
v) The core is annealed according to a designed time temperature cycle under inert atmosphere and magnetic field. The annealed core is wrapped up with insulating cover.

vi) The core is reopened from distributed gap joint and coils are inserted.

vii) Opened layers are folded back to form joint

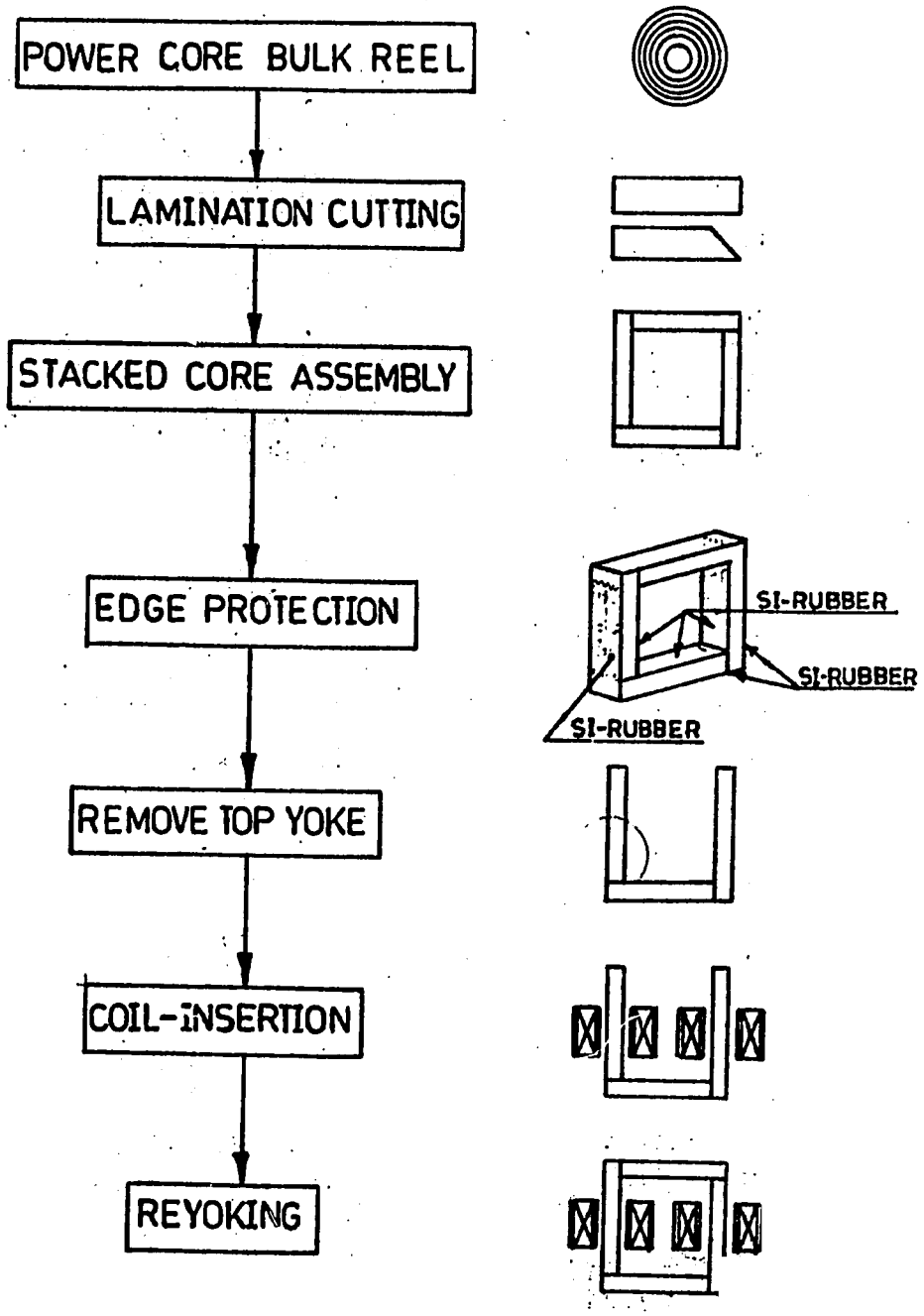
Annexure-B

STEPS INVOLVED IN MANUFACTURE OF DISTRIBUTED GAP ACT FROM AMA RIBBON



Annexure-C

STAGES INVOLVED IN MANUFACTURE OF STACKED CORE ACT STARTING FROM BUNCHED STRIPS (POWERCORE)



CORE-COIL-ASSEMBLY

ANNEXURE-D

PROJECT PROFILE

Consortium R&D Project

1. Proposer : Name - Electrical Research & Development Association

   Address - Post Box No.760,
   Makarpura Industrial Estate P.O.,
   Vadodara 390 010

   Telex - 0175-425 ERDA IN

   Telephone - 42613, 43182

   Gram - ELECSEARCH

2. Name & Designation of contact person : Dr MS Padbidri
   Deputy Director

3. Co-sponsors in the consortium

   1. Electrical Research & Develoment Association

   2. Gujarat Electricity Board,
      Race Course Circle,
      Vadodara 390 007

      Tel. No. 323481

      Telex No.: 0175-264 Gram : GUJELBOAR

      Contact person : Mr VJ Ambwani
      Executive Director(R&D)

   3. Patson Transformers Pvt. Ltd.
      C/o. Voltamp Transformers Pvt.Ltd.
      N.H.No.8, Maneja
      VADODARA
      Tel No. 42478, 42011

      Telex No. 0175-277 Gram : VOLTAMP

      Contact person : Mr. L.H. Patel, M.D.

   4. Power Control Equipment Co.,
      5/12, BIDC, Gorwa Industrial Estate,
      Vadodara 390 016

      Tel. No. 320922

      Telex No. - Gram : POWERLITE

      Contact person : Mr. S.C. Patel, M.D

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5. Ashok Transformers Pvt. Ltd.
Road No.12, Udhyognagar
Udhana 394 210.
Dist. Surat

Tel. No. : 88591, 88592

Telex No. : - Gram : MACTOOLS

Contact person : Mr. P.R. Vakil, M.D.

4. Information on current operations :

- ERDA is a co-operative R&D institution
- GEB is the end-user
- Other 3 participants are transformer manufacturers in small scale sector
- Annual reports/balance sheets attached
- Partial list of projects completed attached Annex I

5. Information on Project

a) Title : Development of Distribution Transformers using Amorphous Magnetic Alloy

b) Scope :

To develop cost effective designs of 3 phase distribution transformers using amorphous alloy with appreciably reduced losses and to manufacture 25 Nos. 63 KVA 3 phase transformers for detailed evaluation and field trials before commercialisation.

Phase I : To design and carry out laboratory evaluation of various designs to arrive at a cost effective solution

Time schedule : 2 years

Phase II : To manufacture 25 transformers : 6 months

Phase III: Reliability/Life/Field evaluation : 2½ years

c) Innovative content

i) Optimisation of annealing - several parameters in the process are variable e.g. temperature, time duration, temperature steps, magnetic field etc. Process optimisation from the cost effectiveness angle to achieve maximum reduction in losses will be the objective.

ii) Technique for producing "power" core - presently available amorphous material is in thin foil resulting in problems in core cutting, core coiling, handling, structural stability etc. Converting this foil into stratified composite by temperature, pressure etc. to facilitate further processing will be the objective.

iii) Optimised core coil configuration - presently available foil poses difficulties in following conventional core coil configurations. Several approaches will be explored and evaluated to have simpler manufacturing process.

d) Use of product/Competitive merits

There are above 8,00,000 nos. distribution transformers in service and about 1,50,000 transformers are getting added every year. These are used primarily in rural and also in urban areas. As these are kept energised 24 hours a day and 365 days a year, the energy lost due to core losses is approximately 150 MW. Introduction of transformers with amorphous alloy will reduce these by at least 100 MW. This is equivalent to 250 MW of installed capacity.

At present these transformers are expected to be costlier compared to the conventional one but reduction in price of amorphous alloy as well as improved design + manufacturing process is expected to make them quite competitive.

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e) Present Status & Brief Review of Work Done

) International Status

Amorphous magnetic alloy is commercially produced by Allied Signals, USA who hold the world patent rights and supply the materials to all countries. In USA, development of this material for distribution transformers has been pioneered by EPRI (Electrical Power Research Institute) and US Govt. through General Electric and Westinghouse. Approx. $10 million have been invested for manufacture and field trials. Besides, several Japanese firms (Toshiba, Dahein, Osaka etc.) are also working vigorously in this field.

ii) National Status

Distribution transformers are manufactured in India mainly in the Small Scale Sector. Hardly any development work has been done for using amorphous material for distribution transformer by the Small Scale Sector till recently.

ERDA with 3 of the local transformer manufacturers have developed a prototype single phase, 10 kVA, 11 kV/0.24 kV successfully. The unit has been tested and 60% reduction in core losses has been achieved.

This transformer is now undergoing field trial by GEB.

f) Major steps involved

1) Import-amorphous alloy for design optimisation and also for 25 nos. transformers for field trial

2) Design optimisation by evaluating various core-coil configurations, yoke sections, annealing paratmers

3) Development of techniques of converting into composite of thicker section for ease in subsequent processing.

4) Laboratory evaluation

5) Manufacture of 25 nos. transformers

6) Field & long term laboratory evaluation

g) Estimated expenditure — Rs.55 lakhs

Break-up: please see Annexure.II

h) Duration — 5 years

i) Allocation of development work amongst participants

1.	Import + Purchase of Raw Materials	: Transformer Manufacturers
2.	Jigs/figures/Tools & Machinery	: -do-
3.	Testing equipment + facilities	: ERDA
4.	Manufacturing of Transformer	: Transformer Manufacturers
5.	Testing, measurement, field evaluation	: ERDA
6.	For 25 nos. Transformers providing facilities for field trials	: GEB

j) Financial exposure of each co-sponsor

Rs.28 lakhs will be contributed by the 3 transformer manufacturers who are co-sponsors. Balance Rs.27 lakhs required as conditional grant from PACER.

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k) Project Management and Control

Project Monitoring Committee, consisting of representatives/nominees of following will monitor and control the proejct:

1. Electrical Research & Development Association
2. ICICI - PACER
3. Patson Transformers Pvt.Ltd.
4. Power Control Equipment Co.
5. Ashok Transformers Pvt. Ltd.
6. Gujarat Electricity Board

6. Tentative plan for commercialization of technology:

A. Manufacturing Capacity:

a) Capacity : 1200 nos./year in 3 ratings

b) Cost of project : Capital cost: Rs.31 lakhs

c) Schedule of implementation :

3rd year - 300 Transformers
4th year - 600
5th year -1200

d) Project sales & profitability:

3rd year - Rs.1.2 crore
4th year - Rs.2.4
5th year - Rs.4.8

B. Licensing of Technology : No licensing envisaged.

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ANNEXURE-I.

TYPICAL PROJECTS UNDERTAKEN
(Sponsors indicated in bracket)

1	Quality improvement of transformer oil manufactured in small scale sector	(Gujarat Govt.)
2	Evaluation of fast deterioration in properties of indigenous transformer oil in storage	(Industry Group)
3	Desludging of energised power transformer	(Utility)
4	Study of impulse breakdown characteristics of transformer oil	(Presented at CIGRE)
5	Evaluation of epoxy-B stage glass cloth	
6	Evaluation of quality of ethyl antioxidants for use in transformer oil	
7	Determination of thermal endurance profile of DMC/SMC	(Industry)
8	Establishment of temperature classification of wood flour filled phenolic moulding materials used in switchgear industry	(Industry)
9	Evaluation of effect of untreated indigenous fillers on epoxy castings	(Industry Group)
10	Determination of optimum drying cycle for PT coils	(Industry Group)
11	Development of flame retardant paint	
12	Evaluation of indigenously manufactured enamelled wires and development of quick quality control tests	(Industry Group)
13	Evaluation of enamelled wire and impregnating compound compatibility	(Industry Group)
14	Functional life test evaluation of distribution transformer design	(R E C)
15	Development of distribution transformer using amorphous alloy steel	(Industry Group)
16	Impulse withstand capability of HT motor coils	(Industry)
17	Study of heat transfer and radiator designs for power transformers	(Industry)
18	Failure study of distribution transformers	
19	Investigation into effect of frequent switching on average Life of tungsten filament general service lamps	(Railways)
20	Study on train lighting lamps under stationery and vibration conditions	(Railway)
21	Partial discharge in XLPE cables due to moisture absorption	
22	Development of 10A drop out fuse element	(Industry)

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23	Reliability studies of power station auxilliary drive motors	(Utility Group)
24	Switching surge measurement on distribution feeders	(Utility)
25	Switching surge effect on transformers with different number of HT coils	(Utility)
26	Study of harmonic voltage distortions in 132KV grid supply system and 25KV traction supply system	(Railway)
27	Determination of maximum safe operating temperature of E91 grade aluminium busbars	(Industry Group)
28	Evaluation of quality and safety aspects of domestic switches, three pin plugs and sockets, GLS lamps, ballasts and starters	(D S T)
29	Improvement of safety and reliability of switches, plugs and sockets.	(D S T)

ESTIMATED PROJECT COST

Phase I		Rupees in Lakhs	
1. Raw Materials			
Amorphous metal for 8 designs 3 Nos. each	4.6 Tons @ 1.5 Lakh/ton	6.90	
Aluminium/copper, Bushings, structurals etc. (Different core coil configuration yoke sections, aluminium copper etc. will be tried		3.50	10.40
2. Machinery			
Annealing Furnace		3.00	
Coil winding machine		8.00	
Core cutting machine		1.00	12.00
3. Jigs/Tools /Fixtures			
For core cutting " winding " coil winding		0.50	0.50
4. Testing Facilities			
Cables, lugs, MCB , relays etc.		0.25	
Amount chargeable for this phase for using existing facilities for measurement and testing e.g. voltage, current power, waveform, Partial discharge, impulse		0.50	
Short circuit testing		1.00	
Additional equipment		3.00	4.75
5. Consumables		0.25	0.25
6. Manpower			
Labour for core, coil, assembly etc.		1.25	
Scientists/Engineers for evaluation/ testing etc.		2.25	3.50
		Total :	31.40

Phase II		Rupees in lakhs	
1. Raw Material			
Amorphous alloy	5 Tons @ 1.5 Lakh/ton	7.50	
Other materials		4.00	11.50
2. Testing			
Chargeable to this phase		0.50	0.50
3. Manpower			
Labour for manufacturing		3.30	
Scientists/Engineers		1.50	4.80
		Total :	16.80

Phase III		
Travel for monitoring etc.	1.00	
Testing facilities chargeable to this phase	0.50	
Purchase of portable CT/PT, Metering sets	1.50	
Manpower	3.50	6.50

Total :	Phase I	-	31.40
	Phase II	-	16.80
	Phase III	-	6.50
			54.70
	Say	:	55.00 Lakhs

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

8th PRC Meeting

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Agenda Item 4

NOTE FROM PACER SECRETARIAT

REVIEW OF PROGRESS OF PROJECTS UNDER FORMULATION

Proposal	Main Proposer	Cost (Rs lac)
a) Development and Demonstration of 30 MWe AFBC Boiler	BHEL, Trichy	1950.00
b) Solar thermal power plant with stretched membrane concentrator and stirling power pack	BHEL, Rudrapur	78.00
c) Development of enchanced capacity 3 ton pay load battery bus	BHEL, Bhopal	52.00
d) Development of 200 KW horizontal axis wind electric generators	BHEL, Hyderabad	90.00
e) Solar powered steam generating system for process industry	KSCST, Bangalore	18.00
f) Demonstration of solar pond for low grade heat	Deejay Hatcheires Bangalore	3.30
g) Commercial R&D of parabolic dish collector decentralised solar thermal power	PAIC, Chandigarh	575.00
h) Building of prototype 10 KVA, 440 V Aero turbine	Manamar Engineers Chandigarh	2.75
i) R&D of industrial and domestic gas flow meters and domestic multifuel gas stove	Total Energy Systems Bangalore	6.00
j) Development of Electrode and Membrane Cell process for chloralkali industry	CECRI, Karaikudi	524.09

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Agenda Items 4 (a), (b) (c) and (d)

Proposals of Bharat Heavy Electricals Limited (BHEL)

PACER Secretariat has been pursuing with BHEL its various consortium R&D proposals. However BHEL is yet to indicate its willingness to accept Conditional Grant which is a major constraint. The issue was discussed with Shri Ramachandran, Executive Director, Finance, BHEL who had mentioned that he would discuss with the concerned Director(s) and seek Board's approval for conditional grant. We still await the communication in this regards from BHEL.

An outline of each proposal from BHEL is enclosed.

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Agenda Item 4 (a)

Proposal	Development and demonstration of 30 MWe AFBC boiler
Proposer	Bharat Heavy Electricals Ltd. (Trichy) BHEL, Ahmedabad Electricity Co. Ltd.
Brief description of the project	BHEL has developed the Atmospheric Fluidised Bed Combustion Boilers of steam generation capacities 10-15 t/hr for the process steam generation. Based on this experience, they have designed 165 t/hr., 65 atmosphere pressure system equivalent to 30 MW for power generation. The design has been studied by Tenesse Valley Authority (TVA), USA. The technology is suitable for the high ash Indian coals.
Cost of the project	Rs 1,950 lacs
Duration	4 years
Status	PRC, at its first meeting had cleared the proposal for further development. PACER Secretariat sent the detailed application form to BHEL. BHEL recently sought clarifications regarding the terms and conditions of the assistance under PACER, which were provided. AEC has informally conveyed its inability to associate with the project. BHEL has agreed to identify any other suitable consortium member such as Indian Aluminium, Calcutta Electricity Supply Co. etc. who may be interested in the development of the technology. BHEL has simultaneously initiated steps to instal a 30 MWe AFBC boiler in place of the stoker fired boiler in an existing power plant with minor changes in the balancing equipment. The estimated cost of this repowering project is about Rs 4-5 crores. This development would be undertaken by BHEL with its own source of finance.

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Agenda Item 4(b)

Proposal	Solar thermal power plant with stretched membrane concentrator, and stirling power pack.
Proposer	Bharat Heavy Electricals Ltd. (Rudrapur) BHEL
Brief description of the project	The proposer intends to import the stretched membrane concentrator, controls, tracking system and stirling power pack from U.S.A. and install a 15-20 KWe demonstration unit at Rudrapur. Based on the trials and tests on this a 50 KWe stirling power pack system would be designed and commercialised.
Cost of the project	Rs 90 lacs
Duration	2 years
Status	PRC had cleared the proposal at its first meeting for further development. It was clarified to BHEL that as the project would result in a commercial product, the proposal would be considered in consortium R&D category wherein the sponsor would bring in 50% of the finance required. BHEL would be submitting the proposal after clearence from its management and identify a member of consortium (a US company). Despite our request to provide a revised proposal based on the above approach, BHEL continues to pursue the idea of securing research award (i.e.80% grant) towards the cost of the project. PRC may discuss this issue and provide guidance for processing the proposal.

Confidential **Agenda Item 4(c)**

Proposal	Development of enhanced capacity 3 tonnes pay load battery bus
Proposer	Bharat Heavy Electricals Ltd, Bhopal
Brief description of the project	It is envisaged to develop 3 tonnes pay load truck keeping the gross vehicle weight at 8 tonnes. The average speed of the vehicle would be 50 Kmph and would use 40 hp motor. The battery would deliver 144 V at 300 AH and would require charging after 75 Kms. The proposal also envisages development of chopper controller, chasis and FRP body. These the vehicle would be tested by a public utility such as DTC or BEST.
Cost of Project	Rs. 52 lacs
Duration	One year
Status	During the fourth meeting of PRC the profile of the project was cleared. PACER Secretariat had discussions regarding the inclusion of the public utility as an end user in the consortium as also the possibility of including battery/light commercial vehicle manufacturer as well. The detailed proposal is awaited.

Confidential **Agenda Item 4(d)**

Proposal	Development of 200 KW Horizontal Axis Wind Electric Generator
Proposer	Bharat Heavy Electricals Ltd., Hyderabad
Brief description of the project	Project envisages development of 200 KW Horizontal Axis Wing Electric Generator with pitch control feature. The machine is expected to be a gear-box mounted type with Fibre glass Reinforced Plastic blades. The project involves selection and design of various subsystems and components, design of system of software, procurement, fabrication of components assembly and field testing of total system.
Cost of Project	Rs. 90 lacs
Duration	2 years
Status	At its 3rd Meeting of ERDAC it was indicated that the proposal could be developed for consideration for support under PACER. Accordingly a detialed form for PACER assistance was sent to BHEL. Officers of PACER Secretariat visited and discussed the proposal with officials of BHEL, Hyderabad. Detailed proposal is still awaited.

Confidential **Agenda Item 4 (e)**

Proposal	Solar powered steam generating system for process industry
Proposer	Karnataka State Council for Science and Technology (KSCST), Bangalore IISc, Bangalore
Brief description of the project	The project envisages development of solar powered steam generating system of 500 kg/hr size for process industry. Project involves development of various components of the system indigenously which include metal absorber, absorber coating collectors, tracking mechanism, etc.
Cost of the project	Rs 18 lacs (likely to be increased)
Duration	Not indicated
Status	At the first PRC meeting, it was indicated that the project may be considered provided a suitable entrepreneur is ready to join as consortium member who later could commercialise the system. KSCST is still in the process of identifying a suitable entrepreneur/manufacturer and user industry in order to form a consortium. Officers from PACER Secretariat called on Shri M. S. Rama Prasad, Director, CREDA, KSCST at Bangalore and had discussion on the project.

Confidential **Agenda Item 4 (f)**

Proposal	Demonstration of solar pond for low grade heat.
Proposer	Karnataka State Council for Science and Technology (KSCST), Bangalore and Deejay Hatcheries Pvt. Ltd., (Deejay), Bangalore.
Brief description of the project	Project envisages construction of a solar pond of 20m x 20m (400 sq. m) size adjacent to the incubators. Project would involve setting the pond into operation after developing 3 zones namely storage, gradient and surface zones. The project involves study of variation temperature of pond during the year and study effect of rain, wind etc. on the performance of solar pond.
Cost of the project	Rs 3.5 lacs
Duration	2 years
Status	At the second ERDAC meeting it was indicated that the above proposal may be developed considering the scope of the concept for wider application in rural economy. KSCST was accordingly requested to provide detailed proposal. KSCST later informed that there was a change in Management at Deejay and hence it may take some time to formulate the proposal. Officers from PACER Secretariat called on Shri M. S. Rama Prasad to discuss the status of formulation of the proposal. It was informed that Deejay has some reservations about the solar pond technology and would like to study effect of salt content in the pond on the neighbouring soil before taking up the proposal. In order to expedite formulation of proposal on solar pond, PACER Secretariat has discussed the concept with Venkateshwara Hatcheries Pvt. Ltd. to form a consortium with R&D institutes like I.I.Sc. or TERI. The reply to the same is awaited.

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Agenda Item 4 (g)

Proposal	Development of parabolic dish collector decentralised solar thermal power station.
Proposer	Punjab Agro Industries Corporation Ltd. (PAIC), Lajet Energy Co. (USA)
Brief description of the project	Project envisages development of parabolic dish collector, tracking system and stirling power pack for decentralised power generation plant of 1-5 MW capacity.
Cost	Rs 575 lacs
Duration	2 years
Status	PRC at its first meeting reviewed the profile and its comments were as follows : Proposer does not have R&D background and engineering base. The data on life of the plant is not available. Some development work has already been carried out by Lajet but such systems have not been proved to be commercially viable. Suitable stirling powerpacks need to be developed for this capacity and clear perception of market in India is necessary. PACER Secretariat conveyed these to the proposers and has not received any communication from PAIC on the proposal.

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Agenda Item 4 (h)

Proposal	Building of prototype 10 KVA, 440 V aeroturbine
Proposer	Manamar Engineers and Consultants Chandigarh and CES Pvt. Ltd., New Delhi
Brief description of the project	Proposers would build an aeroturbine with standard design and materials of constructin. Proposers would carry out tests, generate data and demonstrate use of the equipment for water pumping and agricultural processing operations.
Cost of the project	Rs 2.75 lacs
Duration	
Status	PRC, at its third meeting reviewed the proposal and asked the PACER Secretariat to assess the scope of the R&D project and examine its innovative content after discussion with proposers. Accordingly, the representatives of PACER Secretariat had discussions with the proposers at Chandigarh. PACER Secretariat representatives clarified the procedural aspects of the scheme and the need for further information on the proposal. They also enquired about the innovative content as also into the possibility of expanding the scope of the proposal in order to develop aeroturbines having lower cut in speeds and higher availability in various geographic regions of India. Subsequently, form of applicatin for PACER Secretariat was sent to the proposers. Propsers feel that they would first build the prototype and then, based on trials on it, they would provide data and information necessary to process the proposal. After requesting proposers to send certain basic information on the proposal in order to process it there is no further communication from them. In view of this we recommend that the above proposal may not be pursued.

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Agenda Item 4 (i)

Proposal	:	R&D of industrial and domestic gas flow meters and domestic multifuel gas stove.
Proposer	:	Total Energy Systems, Bangalore
Brief description of the project	:	The project envisages development of domestic gas flow meters where gas is supplied through pipelines to consumers. The project also envisages development of a new burner for domestic gas stove having multifuel capability.
Cost of the project		Rs. 6 lac
Status		The main proposer is unable to form consortium with a suitable co-sponsor and research institution. The proposer has also not provided a detailed project report. In view of the above, we recommend that the proposal may not be pursued further.

Confidential **Agenda Item 4 (i)**

Proposal	:	Development of Electrodes and membrane cell process for production of caustic soda and chlorine.
Proposer	:	Central Electro-chemical Research Institute (CECRI), Karaikudi
Brief Description of the project	:	It is proposed to develop composite cationic exchange membranes indiigenously and modify the electrodes suitably. The project envisages 10 KA capacity, monopolar and bilpolar membranes and 72 KA monopolar membranes.
Cost of the project	:	Rs 524.09 lacs
Duration	:	3 years
Status	:	After the first PKC Meeting, PACER Secretariat asked for clarifications on the details of consortium members especially the manufacturer, who would commercialise the technology later. Details of actual work envisaged were also requested. The proposers have not yet sent the clarifications or reply to subsequent reminders. Officers of PACER Secretariat have also visited the institute and had discussion with the officials on the proposal. It was indicated that the revised proposal would be sent which is still awaited.

The Industrial Credit & Investment Corporation of India Limited

Registered Office:
163, Backbay Reclamation
Bombay 400 020
Phone: Management 245115
General 242535
Grams: CREDCORP Bombay
Telex: 11 3062 ICIC IN

PACER/39847

August 17, 1989

Dr. David Jhirad
Senior Energy Advisor
Office of Energy
U.S. Agency for International
Development
Room 508, SA 18
Washington, D.C. 20523
U.S.A.

Dear Dr. Jhirad:

Fifth Meeting of the Peer Review Committee for PACER

The Fifth Meeting of the Peer Review Committee (PRC) will be held on Tuesday, August 22, 1989 at 11.30 a.m. at the Department of Non-Conventional Energy Sources (DNES), CGO Complex, Block No. 14, Lodi Road, New Delhi 110 003 to consider the agenda enclosed.

We request you to attend the meeting as an observer and join us for lunch thereafter. Kindly confirm your convenience.

With regards,

Yours sincerely,

P. H. Vaidya
Manager
PACER Secretariat

Encl.:

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

FIFTH MEETING OF PEER REVIEW COMMITTEE
ON AUGUST 22, 1989 AT 11.30 A.M.
AT CONFERENCE ROOM, DNES, NEW DELHI

A G E N D A

1 To confirm the minutes of the fourth PRC Meeting held on June 28, 1989.

2. To discuss the consortium proposal for financial assistance.

3. To consider the Research Project Proposal for financial assistance.

4. To discuss the profiles of Research Projects received and take a preliminary view regarding their suitability for support.

5. To review the progress of projects under implementation.

6. Any other item with the permission of the Chair.

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH
(PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 1

Minutes of the Fourth PRC Meeting
held on June 28, 1989

(copy enclosed)

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PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

Minutes of the Fourth Meeting of Peer Review Committee (PRC) held on June 28, 1989 at ICICI, Bombay

The fourth meeting of the PRC was held at 10-30 am on June 28, 1989 in the Conference Room of The Industrial Credit and Investment Corporation of India Limited, (ICICI), Bombay under the Chairmanship of Dr. J. Gururaja, Adviser, Department of Non-Conventional Energy Sources (DNES).

The following members attended the meeting

1.	Dr. J. Gururaja Adviser, DNES	- Chairman
2.	Shri S.S. Betrabet Adviser-Technology ICICI	- Member
3.	Shri V. Bakthavatsalam Managing Director, IREDA	- Member
4.	Dr.S. P.Sukhatme Professor, Deptt. of Mech. Engg. IIT, Bombay	- Member

Leave of absence was granted to the following two members of PRC : Shri V. Raghuraman, Director (Fuel Efficiency), NPC and Shri L.R. Suri, Secretary General, NCPU.

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Also present at the meeting were :

Shri A. J. Advani	)	
Dr. P.H. Vaidya Secretary, PRC	)	
Shri B.A. Bhatt	)	PACER Secreariat
Shri V.M. Deodhar	)	
Shri S.S. Tamhane	)	
Shri S. Padmanabhan		USAID, Delhi

Dr. J. Gururaja welcomed the members and invitees to the 4th Meeting of PRC.

Agenda Item 1 : To confirm the minutes of the Third PRC Meeting held on March 27, 1989

Minutes of the third meeting of PRC held on March 27, 1989 were confirmed. PRC also noted the action taken on points arising from the minutes of the PRC meeting.

Agenda Item 2 : To discuss the consortium R&D proposals for financial assistance.

a) Proposal of Punjab Agro Industries Corporation Ltd. (PAIC), ICB Limited and PRM Energy Systems (Stuttgart Inc., USA) for demonstration plant of a 4 MWe (net delivered) co-generation of power (2.5 MWe) and process steam (8 t/hr) based on controlled combustion technology employing paddy straw/husk as the fuel.

Shri Gokul Patnaik, Managing Director of PAIC presented an overall view of the proposal and Mr. Kelton Grubbs of PRM illustrated the technical features of controlled combustion technology with the help of slides. The presentation was followed by discussions at length involving clarifications and explanations on various points raised by members of PRC.

The PRC decided to recommend the proposal for approval to ERDAC subject to the following observations and suitable modifications :

i) Prior to importing the required Turbo Generator (TG) set having condensing turbine with intermediate steam extraction facility, indigenous availability of such equipment with respect to its cost, delivery schedule and performance levels/parameters may be thoroughly explored and compared to the proposed imported equipment.

ii) Arrangement and mechanism for procurement, collection storage and assured supply of fuel (i.e. rice straw) may be scrutinised;

iii) To ensure proper acquisition/absorption, assimilation and further development of technology, a suitable memorandum of understanding which would be bilateral or tripartite as necessary, may be executed before the first disbursement of proposed conditional grant.

iv) The cost of the project under various heads of expenditure and reasonableness thereof may be closely reviewed;

v) PACER Secretariat may obtain and carefully examine the Detailed Project Report (DPR) on the proposal from PAIC;

vi) To help satisfactory implementation of the project and running of the proposed demonstration plant, a suitable Project Management Committee may be constituted with a representative/nominee of PRC/PACER Secretariat as a

vii) In the event of any shortfall in the means of financing including that arising due to DNES not allowing the grant of Rs. 145 lacs to be utilised for the project, PAIC shall make the shortfall good in form of equity/quasi equity funds and;

viii) PACER Secretariat may depute its oficers to visit existing operating plant(s) of PRM Energy systems abroad to assess the status of development and suitability of the proposed t y.

2b) Proposal of Southern chemical Industries Corporation Limited (SPIC) and S C Science Foundation (SSF) for development and demonstration of solid polymer electrolyte fuel cells (SPEFC) stacks in the range of 1 to 5 Kw

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A brief presentation on the proposal was given by Dr. S. Parthasarathy and Shri V. Venkitakrishnan of SPIC Science Foundation. The PRC decided to recommend the proposal for approval to ERDAC subject to suitable modifications keeping in view following observations :

i) The proposal includes establishment of a full-fledged electrochemical laboratory. The laboratory equipment which is general and non project-specific may be removed from the scope of the project, with a consequential reduction in the cost of R&D project;

ii) Scope for materials development in the proposed project may explored.

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2c) Proposal of Nagadi Consultants Private Limied (NCPL), Micro Controls and TI Cycles for development and demonstration of low cost combustion control system based on oxygen sensing.

A brief presentation on the proposal was given by Dr. Krishna V. Prasad and Shri T. Jayaraman of NCPL.

The PRC agreed with the recommendation of PACER Secretariat to provide to the consortium of Nagadi Consultants Private Limited, Micro Controls and TI cycles a conditional grant of Rs. 4 lacs to meet a part of the cost of the proposed development scheme out of the funds available under PACER on the following main terms and conditions :

1. Before availing of the conditional grant, the proposers shall enter into a Memorandum of Understanding specifying their mutual rights and obligations to the satisfaction of ICICI.

2. The proposers agree to make payments to ICICI of twice the amount of conditional grant disbursed as a negotiated percentage of revenues arising from the project on commercialisation.

3. (a) Machinery or equipment purchased in whole or in part with the conditional grant shall belong to the proposers but shall nonetheless be clearly identified and used only for the proposal purposes, unless ICICI otherwise permits in writing.

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(b) The proposers shall not sell, give on lease, licence to conduct, mortgage, charge or otherwise dispose off the said machinery or equipment except with the prior permission in writing from ICICI.

4. Nagadi consultants Private Limited shall bring in Rs. 4 lacs by way of cash accruals/unsecured loans to meet a part of the cost of the project in a manner and as per a schedule to be finalised in consultation with ICICI.

5. The proposers undertake to bring in aditional funds in consultation with and in a form acceptable to ICICI to meet any shortfall that may arise in financing the project and/or other requirements

6. The proposers shall utilise the conditional grant only in accordance with the Approved Proposal Budget to be finalised in consultation with ICICI.

7. The proposers agree to secure participation of TI Cycles in the form of specific facilities and support required for carrying out the project at their premises as indicated in the proposal.

8. The proposers agree to appoint key persons for implementation of the project in consultation with ICICI.

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9 ICICI and its authorised representatives reserve the right to carry out technical, financial and legal inspections during the implementation of the project.

10. The proposers shall keep ICICI informed about the progress of the project by submitting periodic reports in a form and substance to the satisfaction of ICICI.

Agenda Item 3 : To consider the research project proposal for financial assistance

Proposal of Nimbkar Agricultural Research Institute (NARI) for Techno-economic feasibility project for setting up a 10 MWe biomass based electric power station in a taluka in Maharashtra. After a brief presentation on the project given by Dr. Anil K. Rajvanshi the PRC discussed the proposal at length. Observations of the PRC are as follows :

i) The scope of the project could be expanded so as to identify some more Talukas in the different parts of Maharashtra state to ensure replicability of similar facilities to generate power,

ii) To examine the possibility of reduction of expenses towards travel,

iii) The study should identify consortium members for final implementaion of the project for setting up 10 MWe power plant based on biomass combustion,

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iv) NARI could organise a workshop for presentation of draft report.

The PRC agreed with the recommendation of the PACER Secretariat to provide grant to NARI to undertake the research project to study techno-economics of setting up a 10 MWe biomass based electric power stations in Maharashtra, subject to following :

a) The terms of reference should be revised in order to take into consideration observations made by the PRC and also to indicate specific steps involved.

b) The cost of the project may be finalised by PACER Secretariat after taking into consideration additional expenses required for holding the workshop as also observations made by the PRC in respect of travel expenses.

Agenda Item 4 : To discuss profiles of proposals for consortium R&D and to take a preliminary view regarding their suitability for support.

The PRC discussed in detail various aspects of each proposal and the comments made were as follows:

No.	Proposal & Proposer(s)	Comments
4(a)	Development of heat pump assisted air-to-air de-humidifier and air to water geyser - Balmer Lawrie and Co. Limited and National Chemical Laboratory	As Balmer Lawrie & Co. is not in the field of manufacture of compressors, the PRC felt that the proposed consortium does not have suitable background to take up such R&D project. Hence, the project was not considered supportworthy. In this connection, PRC observed that rtain R&D work on heat

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		at IIT, Madras and IISc Bangalore. PACER Secretariat was advised to contact the above insitutes and explore the possibility of developing a revised proposal with suitable consortium members.
4(b)	Development of continous fluidized bed furnaces for heat treatment - Fluidtherm Technology Pvt. Ltd and IIT, Madras	The proposal may be developed for consideration by PRC.
4(c)	Conversion of bullock and human energy to electrical energy through generation of compressed air - Fluidomat Ltd.	In view of uncertain prospects for commercialisation as also the work accomplished at other organisations such as NITIE, Bombay and Murugappa Polytechnic. PRC considered the proposal not supportworthy.
4(d)	Development of enhanced capacity 3 ton pay load battery bus - Bharat Heavy Electricals Ltd., Bhopal	The scope of the R&D project to be considered under PACER assistance may be restricted to development of improved chopper controller. The PRC indicated that the proposal may be developed further accordingly.
4(e)	Research an development of industrial and domestic gas flow meters and domestic multifuel gas stove - Total Energy Systems	The PRC indicated that the scope of the project may be restricted to development of domestic gas stove and domestic gas flowmeter. In view of the request of proposer for research award the aggregate cost of the project may be pruned down to bare minimum. The PRC considered the proposal supportworthy subject to observations/modifications suggested by the PRC.

4(f)	Development of 40-275 KW power generation system based on briquettting and gasification of biomass residues - Tata Energy Research Institute and Solar Sciences Consulancy (P) Ltd.	The PRC felt that until the results of the proposal from Ankur Energy and Development Alternative are known, support to such proposals may be deferred.

Agenda Item 5 : To discuss the profiles of research projects received and to take a preliminary view regarding their suitability for support

The committee discussed in detail various aspects of each proposal and PRCs comments were as follows:

No.	Proposal and Proposer(s)	Comments
5(a)	Developmentof a computerised total energy audit and management software package for cement industries - Consultancy Development Centre	In view of the inadequate innovative content of the proposal the PRC considered it not supportworthy.
5(b)	Development of computerised Energy Management System for monitoring, optimizing and controlling energy usage in industry - Tata Consulting Engineers	In view of the inadequate innovative content of the proposal, the PRC considered it not supportworthy.
5(c)	Project for policy on use of Natural gas in transport industry - Indira Gandhi Institute of Development & Research Oil and Natural Gas Commission	The PRC was of the opinion that the institute has a capable and dedicated group of researchers and adequate infrastructural support including computers and related facilities. Therefore the cost of the proposal could be suitably reduced. The PRC considered the proposal supportworthy.

5(d)	An extended field experiment on diffusion of fluorescent lamps in the domestic and commercial sector and to assess its impact on the utility system - Lawrence Berkeley Laboratory, Phillips India, Indira Gandhi Institute of Development & Research Bombay Electric Supply and Transport Undertaking.	In view of the wide and universal scope for energy conservation in the field of lighting, it was felt that the actual field experiment of adequately representative size involving a reasonable cost may be supported by more than one funding agency/source as follows : - Energy conservation Fund - DNES - DESU - DEDA and - PACER The proposers may also contribute to financing the project cost alongwith the above agencies/sources. The PRC indicated that the proposal may be developed further accordingly.
5(e)	Programme for inter-action of planters and energy researchers - Tata Energy Research Institute	The proposal was deferred for consideration
5(f)	Study of coconut residues for energy usage - IIT, Bombay	The PRC considered the proposal supportworthy subject to closer scrutiny of cost.
5(g)	Technology options for solar thermal systems in India - Dr. Rao Associates	The proposals were deferred for consideration at the next meeting of PRC.
5(h)	Estimation of export demand potential for Renewable sources of energy in the developing countries - Andhra University	

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Agenda Item 6 : To note proposals not qualifying for assistance under PACER

PRC noted the proposals not qualifying for assistance under PACER.

Agenda Item 7 : To note the status of projects under formulation

PRC noted the current status of projects under formulation.

Agenda Item 8 : Any other item with the permission of Chair

(i) PRC discussed the request for financial assistance to International Workshop on Physics of Solar energy from Indian institute of Technology, Delhi to be held in February 1990 at the IIT and felt that such requests may not be entertained under PACER.

(ii) Dr. P.H. Vaidya, Secretary, Peer Review committee reported to PRC the progress made in implementation of the various PACER proposals sanctioned earlier, which was noted.

The meeting concluded with a vote of thanks to the Chair.

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 2

CONSORTIUM PROPOSAL FOR FINANCIAL ASSISTANCE

	Proposal	Proposer(s)	Project cost (Rs.lacs)	PACER contribution (Rs. lacs)
a)	Development of continuous fluidized bed furnaces for heat treatment	Fluidtherm Technology Pvt. Ltd. IIT., Madras TI Diamond Chain Ltd.	82.00	41.00

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 2 (a)

MEMORANDUM FROM PACER SECRETARIAT ON THE PROPOSAL OF FLUIDTHERM TECHNOLOGY PRIVATE LIMITED, INDIAN INSTITUTE OF TECHNOLOGY, MADRAS AND TI DIAMOND CHAIN LIMITED

PROJECT TITLE : Development of energy efficient continuous type fluidised bed heat treatment furnaces.

PRINCIPAL PROPOSER : Fluidtherm Technology Private Limited
132, III Main Road
Ambattur Industrial Estate
Ambattur
Madras 600 058

PROJECT COST : Rs. 82 lacs

MEANS OF FINANCING :

	(Rs. in lacs)
Proposer's Contribution	
- Fluidtherm Technology Pvt. Ltd.	41
PACER contribution	
- Conditional Grant	41
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PROPOSAL - SUMMARY

The Consortium of Fluidtherm Technology Pvt. Ltd. (FTPL), Madras, Indian Institute of Technology, Madras (IITM) and TI Diamond Chain Limited, (TIDC), Madras proposes to undertake project to develop energy efficient continuous type Fluidised Bed (FB) furnaces for various heat treatment applications. The proposal envisages mainly development of 3 different types of continuous FB furnaces viz a) continuous Sealed quench furnace, b) Rotary retort furnace and c) End heating furnace. These furnaces are not manufactured in the country and have following features: 1) higher thermal efficiency, 2) Smaller in size 3) Shorter start-up time and 4) Lower initial capital cost as also maintenance cost. The design, development and fabrication would be co-ordinated by FTPL while IITM would help in defining process parameters for various heat treatment processes. Rotary retort furnace would be set up and demonstrated at the premises of TIDC (user) while the other two furnaces will be installed at the premises of FTPL.

PROJECT SCHEDULE

Development of Furnaces	:	October 1989 - November 1991
Commercialisation	:	December 1991 onwards

A. MEMBERS OF THE CONSORTIUM

Fluidtherm Technology Private Limited (Principal Sponsor) :

FTPL, a private limited company promoted by N. Gopinath in 1985, is engaged in the manufacture and marketing of batch type fluidised bed (FB) furnaces of various sizes ranging from 5 kg/batch to 1500 kg/batch at Madras, for applications such as heat treatment of gears and automobile components and tools and moulds as well as oxidation of superconducting materials. FTPL has so far supplied more than 20 FB furnaces to various organisations including Mahindra and Mahindra Ltd., Hindustan Motors Ltd., Premier Automobiles Ltd. etc.

As at June 30 1989 the equity capital of FTPL was Rs 4 lacs and reserves and surplus stood at about Rs 21 lacs. The total income of FTPL during 19 months period ended January 31, 1989 amounted to Rs. 86 lacs (Rs 54 lacs on annualised basis) on which it earned operating profit of Rs.11 lacs (Rs 7 lacs on annualised basis). During the five months ended June 30, 1989 FTPL's turnover was Rs 53 lacs on which it earned operating profit of Rs 8 lacs indicating substantial improvement in its operations. For the period of 14 months ending March 31, 1990 the company's turnover is estimated at Rs. 175 lacs with operating profit of Rs. 39 lacs.

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In July 1985 FTPL developed and fabricated a laboratory scale furnace unit and adapted FB for heat treatments such as carburising, nitriding etc. The first full-scale commercial FB furnace was launched in May 1987. Thereafter FTPL has developed and commercialised FB furnaces for plastic and paint stripping and thermal shock testing as also equipment such as quench cooling curve test facilities, silicon carbide heaters and methanol/acetone vapourisers. Details of products and processes developed and commercialised by FTPL are provided in Annexure - A.

Manufacture of important subassemblies and final assembly of the furnaces as also testing is carried out at the establishment of FTPL. FTPL has two work sheds with total area of more than 800 sq. mts at Ambattur Industrial Estate, Madras where facilities for welding, metal working, material handling (automated pulleys) etc have been provided. The other subassemblies and parts are procured from local fabricators.

FTPL is managed by a Board of Directors comprising 5 members with N. Gopinath as Chairman. Gopinath (37) a graduate in commerce, has over 13 years of experience in the heat treatment industry in the field of manufacturing, marketing, errection and commissioning. The day to day activities of FTPL are carried out by 5 Managers, 12 Engineers, 10 technicians and 10 other supporting staff under the overall guidance of N. Gopinath.

Indian Institute of Technology, Madras :
(Co-sponsor)

The Indian Institute of Technology, Madras (IITM), established in 1959 has a number of well equipped laboratories in the fields of Science and Technology and activities of the Institute encompass chiefly 13 departments and a few advanced research centres. The Institute has a Centre for liaision with outside agencies for Industrial Consultancy and sponsored research activities, which provides specialised assistance to industry. Each assignment is routed through the concerned department.

Dept. of Production Engg. and machine tools section of IITM headed by Dr. R. Krishnamurthy, will be associated in the development work. Dr. Krishnamurthy (48) has doctorate in the field of surface engineering and has over 28 years of experience in industry as also in teaching and consultancy. He has published number of papers in the field.

Dept. of Production Engg. is currently engaged in over 12 assignments from companies such as Widia, Fluidtherm, etc. FTPL at present is developing 'boronising process in FB furnaces' with IITM. This process imparts very high surface wear resistance and hardness and is employed for tools and dies. IITM has identified process parameters of the process and trials are conducted at FTPL on laboratory scale continuous sealed quench furnace. The

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metallographic inspection and other tests such as friction and wear characteristic of boride layer testing are conducted at IITM and changes in process parameters are suggested to improve and refine the process.

TI Diamond Chain Limited (TIDC) :
(Co-sponsor)

TIDC, a subsidiary of Tube Investments of India Limited, has facilities at Ambattur, Madras for manufacture of industrial roller chains. TIDC has collaboration with Diamond Chain Company, USA. As on December 31, 1987 the equity share capital of TIDC was Rs. 68 lacs and reserves and surplus stood at Rs. 318.70 lacs. The sales turnover of the company for the year ended December 31, 1987 was Rs. 1128.5 lacs on which it earned an operating profit of Rs. 45 lacs. TIDC is managed by a Board of Directors consisting of 7 members including M.V. Arunachalam as Chairman. The company has ongoing relations with FTPL and is interested in development of continuous rotary retort FB furnace which would be useful for heat treatment of various components of chains such as roller pins, bushes, connecting links etc.

B. STATEMENT OF THE PROBLEM

Heat treatment of metallic components is an essential step in metallurgical and mechanical industries to get required structures and properties. Success of heat treatment operations

depends upon stringent control over atmosphere as well as temperature. Fluidised bed offers a better solution to this problem as it fulfills most of the requirements. Fluidised beds have excellent heat transfer characteristics and offer precise temperature control and temperature uniformity. These advantages led to development of fluidised bed (FB) furnaces in early 70's mainly in Russia and East Europe. The development of FB furnaces further picked up after oil crisis.

The FB furnaces can be used for various heat treatments processes such as hardening, tempering, marquenching, wire patenting, tool steel processing, carburising, nitriding etc. The details of the principle of operation of FB furnace and its advantages are explained in Annexure - B. Comparison of power consumption in FB furnace with that in conventional furnace is provided in Annexure - C

The FB furnaces can be categorised on various bases such as a) continuous and batch type, b) externally heated, submerged combustion type, internal combustion type c) electrically heated, oil/gas fired, biomass fired, wood waste fired etc. Batch type furnaces in general are used for smaller production scales ie upto 100 kg/hr whereas continuous type of furnaces are used for high production volumes.

FB furnaces have been developed and commercialised in a few advanced countries. At present FTPL is the only company in India to develop, design and manufacture 'batch type' FB furnaces. The indigeneously manufactured continuous FB furnaces are not available in the country at present. The continuous FB furnaces are preferred over conventional furnaces mainly for their following advantages over conventional ones :

a) Its thermal efficiency is higher than that of conventional furnace.

b) The size of continuous FB furnace is almost 1/3rd of that of conventional continuous furnace

c) It takes a shorter start-up time and attains steady state faster.

d) The initial capital cost is lower

e) It is more versaltile and flexible as it can be used for variety of applications.

On the basis of its experience in development and commercial production of batch type FB furnaces, FTPL proposes now to undertake development of continuous type of FB furnaces for heat treatment.

The main problems to be tackled in succfessful development of continuous FB furnace include, stability of fluidised bed, design of transportation system process control

instrumentation, prepared atmosphere systems and heating systems. These problems also exist in case of development of FB furnaces such as sealed quench furnaces, oil fired furnaces, coil wire furnaces, rotary and oscillating hearth furnaces. It may be noted that transfer of technology or know-how for manufacture of these furnaces would require payment of large sums to the collaborator as fees and royalty of about Rs. 50 lacs for each type of furnace. Thus indigenous development of these furnaces would be a significant achievement.

Work done so far : As a part of experimental set up for study on fluidised bed boronising, FTPL has developed laboratory scale continuous FB furnace with 'transportation hood'. The hood is used for transfer of components heated in laboratory scale FB furnace to quench tank under inert atmosphere. The hood moves on rollers over a guide plate. The FB furnace, quench tank and transportation hood together constitute continuous FB furnace. FTPL has initiated conceptual design work of proposed furnaces to be developed.

C. TECHNICAL PROPOSAL

FTPL and IITM jointly propose to develop continuous FB furnaces for heat treatment. FTPL would design, fabricate, test and commission the furnaces whereas IITM would provide necessary support for development of heat treatment processes on continuous FB furnaces. TIDC would provide necessary facilities and support for demotration of one of the furnace prototypes (i.e. rotary retort type).

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The project envisages design, development and fabrication of following 3 different types of continuous FB furnaces :

a) sealed quench furnace;

b) rotary retort furnace; and

c) end heating furnace (for forging application)

Additionally FTPL proposes to develop and fabricate few other subsystems such as travelling hood, oscillating hearth/fixture, endogas generator, quench vestibule, quench tanks and indirect oil heating subsystems. With these subsystems, FTPL can demonstrate 3 more types of furnaces as follows :

a) batch mode of operation of sealed quench furnace

b) oil fired furnace

c) oscillating hearth furnace

The specifications of each of the furnace prototype to developed are given in Annexure - D.

The development of continuous type FB furnaces would involve development of various furnace support systems which include :

i) Computerised process control systems

ii) Prepared atmosphere systems

iii) Transportation systems

a). Travelling hood

b) Quench vestibule

c) Walking beam and

d). Scroll

iv) Alumina recovery/cleaning systems and

v) Heating systems

The main features and other details of development of each support system are provided in Annexure - E

FTPL alongwith IITM would refine various heat treatment processes for application in continuous FB furnaces. IITM would provide support for defining process parameters as also it would help standardising process by metallurgical analysis of heat treated componments(test samples). IITM would provide its report on micro hardness profile, metallographic examination. consistency of results over number of trials as also with respect to location of charge in the fluidised bed.

In order to further enhance the usefulness of continuous FB furnaces, FTPL also standardise processes for Ferro Oxy nitrocarbonising which imparts corrosion resistance to the heat treated components. FTPL proposes to undertake the above powers development is association with College of Engineering, Pune. As regards quenching in continuous FB furnaces, FTPL would seek consultancy services from R.W. Reynoldson, an Australian citizen experienced in Kinetics of heat transfer in FB furnaces.

The main stages in development of these furnaces include :

a) **Design of each subsystem, component and furnace as a whole:** This would mainly involve identifying various process parameters to be achieved in each furnace and deciding specifications of standard components and subsystems. Detailed drawings would be prepared for various subsystems.

b) **Planning of procurement and production of materials:** A detailed plan for procurement of standard components and subcontracted items would be prepared. The schedule for inhouse fabrication of important components and final assembly and testing would be finalised.

c) **Subassembly contracting:** The procurement plan would be executed by giving contracts to various suppliers, fabricators to get materials.

d) **Assembly:** Assembly of each furnace would be carried out by FTPL at its factory. It would involve welding of various components and subassemblies and other related work.

e) **Testing and commissioning:** This is the most important step wherein each furnace would be tested and commissioned after its assembly. IITM would play major role by specifying process parameters and assessing

success of process. Components will be tested after heat treating them in trial runs. Necessary modifications in furnace hardware would be carried out before final commissioning.

FTPL would instal and commission rotary scroll furnace at the premises of TI Diamond Chain Limited and it would be available for demonstration to prospective buyers. The other types of furnaces would be demonstrated at the premises of FTPL.

D. IMPLEMENTATION PLAN

The proposed project would be carried out jointly by FTPL and IITM. As detailed above FTPL would mainly carry out design and fabrication of furnaces whereas IITM would provide necessary support in testing heat treated components and advising on process parameters. A bar chart representing plan of implementation is provided in Annexure - E. The development project would be completed in 26 months after its commencement.

The fabrication of important components such as diffuser and final assembly would be carried out at the establishment of FTPL where necessary facilities have been provided. IITM has well equipped laboratory with most modern testing equipment for X-Ray diffraction and metallography.

The project would be carried out by 2 design engineers, 1 process metallurgist, 5 technicians and 1 materials officer under the overall guidance of N. Gopinath and S. Dilip, Director.

Dillip is a metallurgical engineer and has 13 years of experience in production activity of which 7 years in production of heat treatment equipment. The activities at IITM would be coordinated by Dr. R. Krishnamurthy who would be assisted by 1 M. Tech. student.

E. COST OF THE PROJECT

The cost of the proposed scheme is estimated at Rs 82 lacs as follows which would be incurred over a period of 26 months.

(Rs in lacs)

	Years 1	2	3 (2 months)	Total
Equipment				
- Furnace prototypes	20.90	8.00	-	28.90
- Attachments - (subassemblies)	17.30	2.00	-	19.30
- Laboratory equipment	9.30	-		9.30
Salaries and wages	2.60	2.60	0.50	5.70
Materials, stores and other consumables	4.35	2.15	0.30	6.80
Utilities	0.50	0.50	0.50	1.50
Travel	0.20	1.80	0.50	2.50
Data processing	0.50	0.50	-	1.00
Consultancy	3.00	-	-	3.00
Others	1.80	1.80	0.40	4.00
	60.45	19.35	2.20	82.00

Equipment include 3 FB furnace prototypes (namely continuous sealed quench furnace, end heating furnace and rotary retort), subassemblies/attachments (in order to demonstrate heat treatment processes and other types of furnaces e.g.oscillating hearth furnace would be demonstrated by developing oscillating fixture) and laboratory equipment. Laboratory equipment mainly includes micro hardness tester, oscilloscope, orsat apparatus, a laboratory model high temperature furnace etc.

Salaries and wages are provided for 2 senior engineers, 1 metallurgist, 1 materials officer and 5 technicians. Materials, stores and consummables include alumina, gases, methanol, quench oil, salts, electrodes for welding and jigs and tools. Utilities have been considered for manufacture, commissioning, demonstration and trials. Travel accounts for foreign and domestic travel. Foreign travel expense of Rs. 2 lacs account for 2 trips to USA for meeting with consultants and 1 trip each to Far east and USA for promotion of products totaling to 35 mandays.

Consultancy is sought in areas of (a) Heat transfer while quenching in fluidised beds and (b) Ferritic oxy nitrocarburising an application area in these furnaces. A few consultants have been identified all over the world and the estimate herein is based on the general figure for metallurgical consultancy of US$ 25 per working hour. The terms of reference

considering Fluidtherm's design strength will be restricted to basic concept and after treatment analysis of results (trouble shooting). The estimate is for 100 full time consultant days.

F. MEANS OF FINANCING

The cost of the proposed development project estimated at Rs. 82 lacs is proposed to be financed as follows :

	(Rs. in lacs)
Proposer's contribution	
- Fluidtherm Technology Pvt. Ltd.	41.0
Conditional Grant under PACER	41.0
	82.0

Contribution from FTPL : During the 5 months period ended June 30, 1989 FTPL's cash accruals amounted to Rs. 8.40 lacs. The cash accruals of FTPL during the next two years of operations are expected to be about Rs. 40 lacs and Rs. 60 lacs. Based on these projections the company is expected to meet its contribution through cash accruals. We propose to stipulate a condition that FTPL would contribute to the proposed project in the form of interest free unsecured loan, in the event of shortfall in cash accruals.

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Conditional Grant under PACER : It is proposed to provide conditional grant of Rs. 41 lacs out of funds available under PACER. The conditional grant will be repayable after successful commercialisation of the continuous FB Furnaces. Payments to PACER will be a negotiated percentage of revenue arising from the project on commercialisation including job work and limited to a maximum of 200 per cent of the PACER contribution towards the project cost. The proposers would also pay 50% of the revenue earned by selling prototypes developed under the project toward repayment of conditional grant. We are stipulating suitable conditions in this regard.

G. PROSPECTS

At present there are only 6 major manufacturers of FB furnaces in the world including FTPL. Others include Schwing, W. Germany; Procedyne Corpn., USA; Fluidfire, U.K.; CanEng, Canada and Komastu, Japan. Thus FTPL is the only manufacturer of FB furnaces in India. The cost of an imported FB furnace is almost 2 to 3 times that of FTPL's equivalent furnace. (eg for a particular type of batch type FB furnace Procedyne Furnace Rs. 14.50 lacs - 1985 prices, Schwing Furnace Rs. 23.61 lacs - 1986 prices and Fluidtherm Rs. 7.87 lacs - 1989 prices). The FTPL would have price advantage over imported FB furnaces. It may be noted again that products of FTPL are exempted from sales tax as also 100% depreciation can be claimed in the year of installation as they are classified as energy saving devices.

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Heat treatment process is an important step in manufacture of automobile components or parts of machine tools to get certain properties in metal. Heat treatment furnaces are essential equipment in automobile industry (and automobile ancilliaries), machine tool industry, plastic industry, tool and die industry and engineering industry in general. The typical components which can be heat treated in continuous FB furnaces include gears, crank shafts, valves, engine components, fasteners, turbine components, press tools, extruders, die casting moulds and cutting tools.

In the recent years automobile industry has grown rapidly. The average growth rate of automobile industry is expected to be about 10% during the eight plan period. With the implementation of phased indigenisation programme to be undertaken by various automobile manufacturing units and its ancilliaries there would be increasing demand for energy efficient continuous fluidised bed furnaces. In addition it would be economical for such units to go for continuous type of heat treatment furnaces as the rate of production in these units would be higher.

It is expected that the energy consumption in case of the proposed furnaces to be developed under the project would be significantly lower as compared to conventional furnaces for similar heat treatments (please refer to Annex-C).

Based on growth in automobile industry and other industries mentioned above there would be good demand for heat treatment equipment. FTPL proposes to manufacture and market rotary retort, oscillating hearth, sealed quench, end heating, gas fired continuous FB furnaces in that order after development.

H. BUSINESS PLAN

FTPL proposes to manufacture various types of continuous FB furnaces after their development using existing manufacturing facilities, at Madras. FTPL proposes to manufacture 10, 13, 18 and 22 continuous FB furnaces in the 1st, 2nd, 3rd and 4th year of commercial operations respectively. FTPL would require additional investment of Rs. 65 lacs for commercialisation, of which Rs. 35 lacs would be required to build an additional workshed together with necessary equipment on existing plot and Rs. 30 lacs would be required for increase in working capital. The company proposes to raise suitable term loan from Bank to meet a part of the cost of the commercial project.

The operating results and profitability in respect of commercialisation of continuous FB furnaces by FTPL are provided in Annexure - G. The turnover of continous FB furnaces is expected to increase from RS. 100 lacs in the 1st year to Rs. 350 lacs in the 4th year of commercialisation. The project is expected to earn operaing profit of Rs. 8 lacs in the 1st year of operation which would increase to Rs. 43 lacs in the 4th year of operation.

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In addition to the above FTPL expects to sell some of the prototypes of continuous FB furnaces after their development and successful demonstration to interested users under the project. The company is expected to pay 50% of the income derived from above sale towards repayment of the conditional grant. The company also proposes to undertake job orders for heat treatment of various components during the course of demonstration of these furnaces. These two aspects have not been taken into account for projecting operating results of the commercial project.

I. STRATEGIC ANALYSIS

The proposed project has been analysed in terms of business attractiveness and consortium strength factors. The details of analysis are provided in Annexure- H . It may be observed that the business attractiveness score is 42 while the consortium fit score is 45 each out of the possible 60 points score. The aggregarte score works out to 87 points which is above cut-off points of 70 points. The aggregate score indicates good success potential for the proposed development project.

RECOMMENDATION

FTPL is the first company to develop and manufacture batch type continous fluidised bed furnaces for heat treatment and various other applications in the country. The company has

good track record of development. It has ongoing projects for development of processes with IIT, Madras. The proposed development project of FTPL would result into development and commercialisation of more versatile energy efficient heat treatment furnaces at economically attractive cost.

We recommend providing to consortium of FTPL, IITM and TIDC a conditional grant of Rs. 41 lacs to meet a part of the cost of proposed development scheme out of funds available under the Program for Acceleration of Commercial Energy Research (PACER) on the following main terms and conditions :

1. Before availing of the conditional grant, the proposers shall enter into a Memorandum of Understanding specifying their mutual rights and obligations to the satisfaction of ICICI.

2. The proposers agree to make payments to ICICI of twice the amount of conditional grant disbursed

   (a) as a negotiated percentage of revenues arising from the project including job work on commercialisation and/or

   (b) by way of paying 50% of the revenue earned by selling prototype furnaces developed under the project.

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3. (a) Machinery or equipment purchased in whole or in part with the conditional grant shall belong to the proposers but shall nonetheless be clearly identified and used only for the proposal purposes, unless ICICI otherwise permits in writing.

(b) The proposers shall not sell, give on lease, licence to conduct, mortgage, charge or otherwise dispose off the said machinery or equipment except with the prior permission in writing from ICICI.

4. The proposer shall bring in Rs 41 lacs by way of cash accruals/interest free unsecured loans to meet a part of the cost of the project in a manner and as per a schedule to be finalised in consultation with ICICI.

5. The proposers undertake to bring in additional funds in consultation with and in a form accepable to ICICI to meet any shortfall that may arise in financing the project and/or other requirements.

6. The proposers shall utilise the conditional grant only in accordance with the Approved Proposal Budget to be finalised in consultation with ICICI.

7. The proposers agree to secure participation of TI Diamond Chain Limited in the form of specific facilities and

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support required for carrying out the demonstration of rotary retort FB furnace at their premises as indicated in the proposal.

8. The proposers agree to appoint key persons for implementation of the project in consultation with ICICI.

9. ICICI and its authorised representatives reserve the right to carry out technical, financial and legal inspections during the implementation of the project.

10. The proposers shall keep ICICI informed about the progress of the project by submitting periodic reports in a form and substance to the satisfaction of ICICI.

Annexure - A

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(List of products/processes developed and commercialised by FTPL)

(Ref. Page 4)

Sr. No	Product/ Process	When commercialised	No. of units sold	Aggregate Sale (Rs. in lacs)
1.	Fluidised Bed Batch Type furnaces	May 1987	22	80
2.	In line/batch vapour Degreasers	Early 1986	6	12
3.	Methanol/Acetone Vaporiser	Mid 1987	6	3
4.	Quench cooling curve test equipment	Mid 1987	1	2.5

Annexure - B

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(Details of principles of operation of FB furnaces and advantages of using FB furnaces)

(Ref. Page 8)

The Principles of operation of FB furnaces :

Fluidisation occurs when a stream of air or gas is passed upward through a bed of finely divided particles. At a certain velocity, the particles separate and float on a cushion of the fluidising air or gas. When the velocity is increased, bubbles form and as they rise through the bed, they cause rapid mixing of the particles in all areas of the bed.

When fluidised, the bed behaves just like a liquid. It is buoyant and light objects float while heavy objects sink. When heated the fluidised bed becomes an excellent media for heat transfer.

Aluminia is used as the fluidising media. Mixtures of Air, Ammonia, Nitrogen, LPG and many other gases are used as the fluidising gas as well as the heat treating atmosphere. The gas reactions take place in the bed itself without need for a gas

An alloy retort is used as the container and a special alloy distributor system ensures uniform fluidisation. The bed is heated by gas or electricity externally and in some cases internally. The components are immersed into the bed and lifted out when the treatment cycle is complete, usually with the help of a hoist.

ADVANTAGES

LOW OPERATING COSTS

The heat transfer rate (4 to 25 times faster than convection/radiation furnaces) cuts down cycle times. Larger tonnage can be processed in smaller furnaces. When a FB furnace is not in use it can be switched off even overnight, the bed retains most of its heat and only needs incremental heating the next day. Therefore its idling is unnecessary which in turn results in saving of energy.

The need for effluent treatment and disposal does not arise and precleaning expenses reduce. All these and other features like low maintenance, no fume handling, lower LPG storage, no gas generator etc., combine to yield an operating cost per kilo that is 50% to 70% of conventional heat treatment equipment (See enclosed cost sheet).

LOW MAINTENANCE

There are no moving parts like fans, conveyors, etc. as in conventional furnaces and hence no attendant maintenance problems. Soot formation does not pose problems as the soot deposits on the particles are burnt off at the bed surface. The alumina particles are inert and do not require rectification, regeneration or monitoring. Such features built into Fluidised Bed Furnaces make them maintenance free equipment.

CLEANING

Precleaning and drying of components required for processing in atmosphere and salt bath furnaces are not required when using Fluidised Bed Furnaces. Oil and moisture on the components and jig simply vaporise without the hazard of explosion. Some alumina which adheres to threads, blind holes and the like can be easily washed or blown off.

QUALITY

The high degree of temperature uniformity (±3 C.) causes extremely uniform heating of all components, even in very dense loads. Distortion is reduced by the bed buoyancy and uniform heating of components.

During case treatments non uniform case depths do not occur. The component surfaces are continually exposed to fresh reactive gases under pressure and are scrubbed by the particles

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which also remove carbon build up on edges and corners. Once the parameters are set, consistent quality is obtained, as long as the process is operated.

POLLUTION FREE

Fluidised Bed Furnaces are not poisonous, do not attract the provisions of health and pollution laws and are safe for those operating them. Effluent treatment and disposal equipment are not required.

LOW CAPITAL COST

Fluidised Bed Furnaces cost less than equal capacity, vacuum, sealed quench and pit type furnaces and even salt baths (when effluent treating and safety equipment costs are added). One furnace performs many processes hence additional furnaces for specific low volume applications are not required.

EASE OF OPERATION

Fluidised Bed Furnace operation is simple and safe. It involves only setting the desired temperature and gas flow (done automatically in certain models) and immersing the components. At the end of the cycle, the components are lifted out and the furnace is switched off while waiting for the next batch.

The advantages of fluidised bed furnaces over conventional furnaces can be summarised as follows :

1. High heat transfer rate - hence shorter cycle time and faster attainment of steady state.

2. Flexibility to switch on/off - hence no 'idling' energy consumption, as there is high heat retention;

3. The same furnace can be used for variety of heat treatments;

4. High degree of temperature uniformity;

5. Minimum downtime, as no precleaning and minimum post cleaning;

6. There is no loss of material due to scaling;

7. Lower running and maintenance cost; and

8. There are no furnace burnouts as also there are no explosion hazards;

Enclosure to Annexure-B

Enclosure to Annexure-B

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED
HEAT TREATMENT COST SHEET

TREATMENT	:	CARBURISING
FURNACE	:	MODEL 1000.60/91 (CN) Max Temp 1050 Deg C
COMPONENT WEIGHT	:	225 KGS / LOADS. COMPONENTS : GEARS
FIXTURES WEIGHT	:	75 kGS TEMPERATURE : 950 Deg C GAS FLOW RATE : 11M3/Hr
START UP TIME	:	1.5 Hours (after night shut down)
RECOVERY TIME	:	0.75 Hours
TREATMENT TIME	:	BOOST - 1.50 Hours DIFFUSE - 1.0 Hour

FLUIDISING GAS

TOTAL CYCLES/DAY = 4
TOTAL LOAD/DAY = 900 KGS

DURING RECOVERY	:	N2	- 100%
DURING BOOST	:	AIR	- 86.0%
		LPG	- 14.0%
DURING DIFFUSE	:	N2	- 100%

COST CLASSIFICATON

Costs are divided into variable costs and fixed costs

			(In Rs.)
A.	VARIABLE COST	-	
a.	Furnace Start up (Cost of heating up the furnace to operating temp - Once a day)	-	48.40
b.	Processing Cost		
	During Recovery and Treatment		
	Electricity	-	300.00
	Gas	-	906.60
B.	FIXED COSTS (3 shifts basis)		
c.	Oxide Consumption	-	51.00
d.	Jigs and Fixtures	-	44.00
e.	Maintenance	-	197.08
f.	Wages	-	24.00
g.	Depreciation	-	350.00
			1921.08
	TOTAL ROAD / DAY		900 KGS.
	TOTAL COST / KG		Rs.2.13

NOTE : Above figures are on the basis of actual trials conducted at the Fluidtherm Plant working for 2 shifts only. If operated for 3 shifts the variable costs and the tonnage will rise and the revised cost per kilo processed will be Rs.1.86/Kg

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FLUIDTHERM TECHNOLOGY PRIVATE LIMITED

INPUT FORMULAE AND ASSUMPTIONS

a. FURNACE START UP = $\frac{\text{Start up time x Max KW x Electricity cost}}{2}$

b. START UP GAS = Since fluidisation by air Blower Motor KW x Start up time

c. HEAT TREATMENT ELECTRICITY = ((Recovery time x Max KW) + (Soak time x Power loss in KW)) x Unit cost of electricity.

d. HEAT TREATMENT GAS = Flow per hour x Rate per CF x Hrs/Cycle

e. OXIDE CONSUMPTION = 3 Kgs x Rate/Kg

f. JIGS AND FIXTURES = Rs.44/- per day

g. MAINTENANCE (Parts & Labour) = $\frac{\text{7\% of Furnace Price}}{\text{250 days / year}}$

h. Wages = Hours per day x cost per hour

i. Depreciation = $\frac{\text{Furnace Price}}{\text{8 years x 250 days/year}}$

1. Cost of Electricity = Re.1.00/KW hr
2. Oxide Consumption = 0.5%/day
3. Cost of Jigs and Fixtures = Rs.11000/year
4. Oxide Rate/Kg = Rs.17.00
5. Work days/year = 250 days
6. Depreciation Period = 8 years
7. Nitrogen cost/M3 = Rs.9.00
8. Ammonia Cost/M3 = Rs.12.86
9. LPG Cost/M3 = Rs.20.00

Annexure - C

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(Comparison of power consumption between Fluidised Bed Furnaces and Conventional Furnaces)

(Ref. Page 8)

COMPARISON OF POWER CONSUMPTION

Process under consideration : Carburising

Case depth : 1 MM.

(in KW/Kg.)

		Fluidised Bed	Conventional
1.	Sealed quench	0.65	1.60
2.	Rotary scroll	0.84	1.57
3.	End heating	0.80	2.60
4.	Continuous gas carburising	0.30	2.20

Annexure - D

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

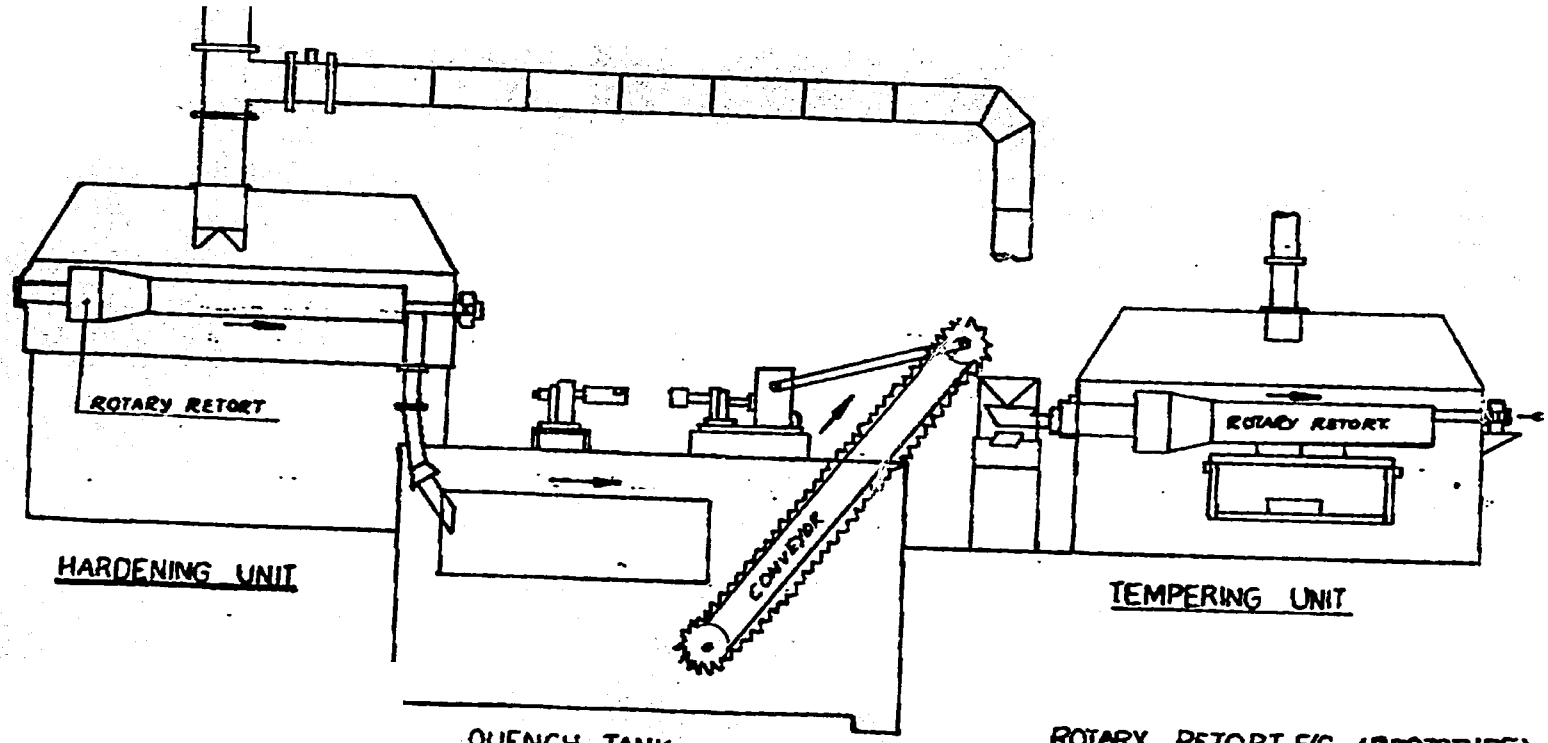
AND

TI DIAMOND CHAINS LIMITED

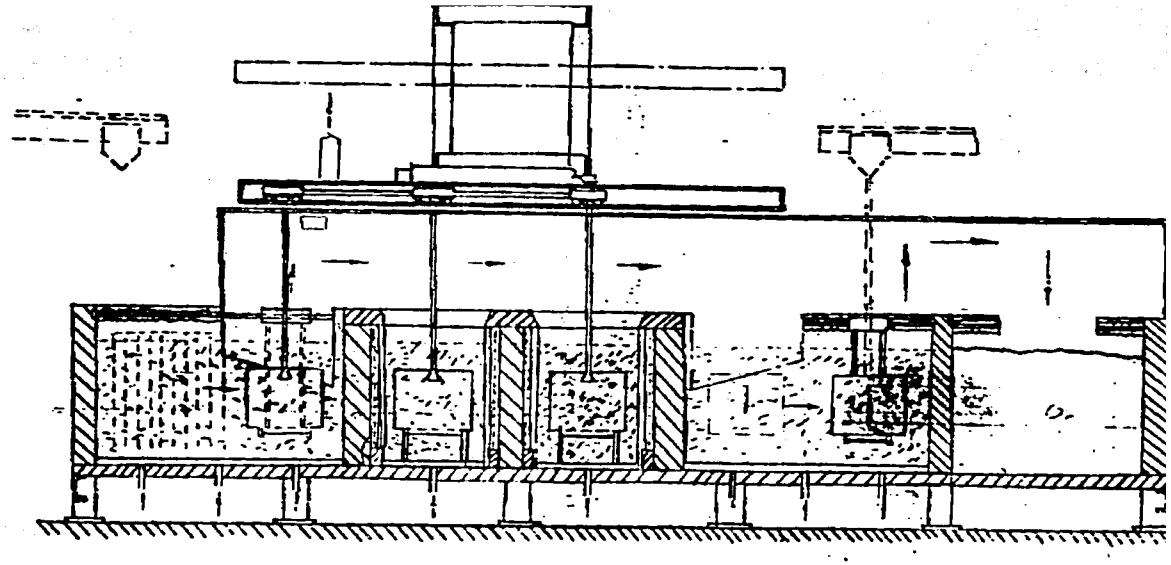
(Specifications of the Furnace Prototypes proposed to be developed)

(Ref. Page 11)

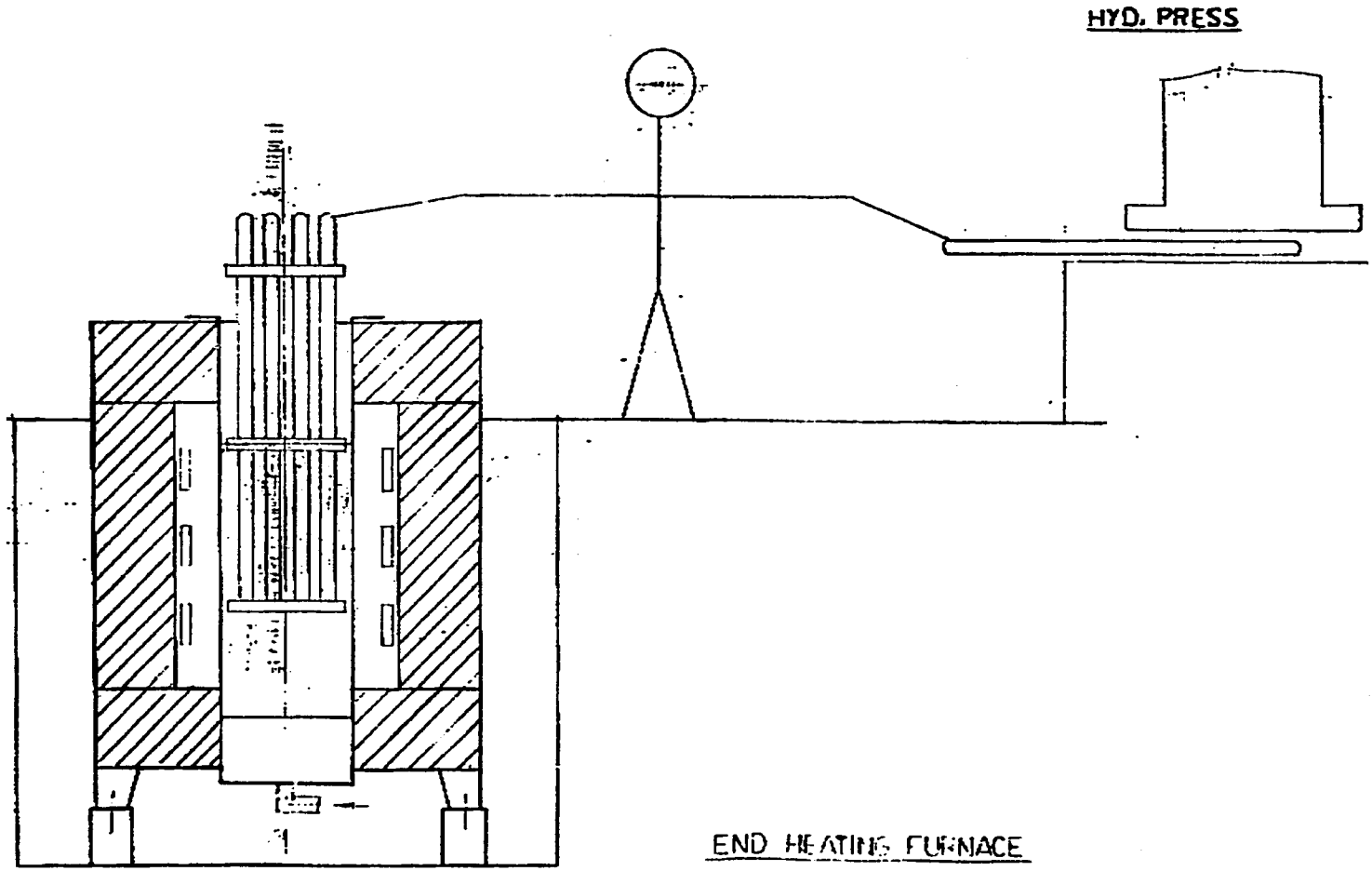
Types	Hot Zone Size	Batch/Hourly Capacity	Temperature
CONTINUOUS FURNACE			
IN CONTINUOUS MODE	300 mm dia x 600 mm deep 4 chambers	100 kg/hr. carburising 0.6 mm	1050 deg C
(IN BATCH MODE)	300 MM X 600 x 1 chamber	100 kg/batch	1050 deg C
ROTARY RETORT	450 mm dia x 900 mmL Retort x 2 (Hardening and tempering)	100 kg/hr Hardening 2 mm thick chain link plates	950 deg C
(OSCILLATING FIXTURE)	Suits any one chamber of the continuous furnace	25 Kg/hr. of 2mm thick chain link plates	950 deg C
END HEATING FURNACE	450 mm diax300 deep	48 bars of 25 mm dia/ per batch. Output 1 bar every minute	1200 deg C
(OIL FIRING MODULE)	Will be used on Rotary retort furnace with retort removed	can heat upto 500 kg/ hr of 16 dia bars	1200 deg C



ROTARY RETORT F/C (PROTOTYPE)



CONTINUOUS SEAL QUENCH FURNACE


HYD. PRESS
END HEATING FURNACE

Annexure - E

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(Main Features of Development of Support Systems)

(Ref. Page 11)

1. **Computerised process control systems:**

The process control can be basically done with the help of Programmable Logic Controller (PLC) which consists of CPU and input/output modules. The PLC controls the process on the basis of pre-programmed path of control which is effected by sequential switching of various outputs. The extension of this system is to use a Personal Computer (PC-AT type) loaded with actual process software. The programme for computer can be much more detailed and flexible than PLC software, thus the scope of control is vastly extended. The main area where the work is needed is development interface between PC and PLC. The PC based control system would be able to control operations including loading/unloading of furnaces, switching furnace temperatures with respect to process time, auto correction/compensation for time lost due to interruptions, power failures etc. and data logging.

2. **Prepared Atmosphere Systems:**

The cost of Nitrogen, especially in low temperature treatments is somewhat high and low cost systems currently

available for conventional furnaces are sought to be adapted for use for FB furnaces. In these cases, different gas mixtures are used directly (such as Nitrogen/Methanol systems) or are used after they have reacted in a separate gas generator (like Endogas and Exogas - both mixtures of LPG and Air).

The development aspects for adapting this system for use in FB furnaces includes vaporisation and super-heating of directly used liquid/gas mixtures in equipment that do not cause sooting and which have an accurate flow and outlet pressure control.

Modification of standard endogas generator would be carried out for following purposes :

(a) Trapping water vapour;

(b) Boosting pressure from 5 Kpa to 30 Kpa;

(c) Installing cold gas atmosphere sensors and

(d) Developing soot traps.

3. **Transportation Systems**:

The project envisages development of following transportation systems for continuous type FB furnaces :

(a) Travelling hood

(b) Quench vestibule

(c) Walking beam and

(d) Scroll

a) Travelling Hood: An inverted hood that travels on rails is used for carrying components to furnace chambers and tanks. Though similar system exists in case of plating plants, certain modifications would be carried out for adopting it for FB furnaces.

b) Quench Vestibule: In cases where complete heat treatment cycle is carried out with one FB furnace and one quench tank, then the travelling hood is not needed. FTPL proposes to attach FB furnace and quench tank together and entire top portion to cover with steel box (vestibule) with three doors. A pusher would be synchronised with the furnace door which would be used to transfer the components. The components would be transported in vertically stored position (vertical repose) instead of horizontal repose.

c) Walking beam: This system is used in long rectangular furnace wherein fixture which holds component is transported with the help of walking beam mechanism. This system is widely used in conventional furnaces which would be modified to achieve lift of about 800 mm instead of 200 mm.

d) Scroll: This is a part of rotary retort furnace which is partially submerged in FB. The components are conveyed from one end to another with the help of hellical baffles. The main developmental work involved is immersion of retort in fluidised bed for faster heat transfer.

4. Alumina Recovery/Cleaning Systems:

Components which have been processed in FB furnaces tend to have alumina particles adhering to them. It is necessary for downstream processes to remove this alumina and also to recover the removed alumina for re-use in the bed.

The first stage is the recovery of 'drag out' alumina from the quench oil or salt. This is sought to be achieved by traditional filtration. The development aspect lies in that the alumina particles are extremely tiny (o.1mm diameter) and on line filtration will slow down the velocity of the oil flow (velocity being critical for the process). This system has to be modified for localised collection of alumina away from the main flow and a batch wise independent filtration system. Prior to this, to reduce the drag out itself, a simple cam operated jig shaker mechanism would be developed to shake to jig wile lifting the charge so as to drop the drag out alumina into the bed.

5. Heating Systems:

Current FB furnaces employ indirect electric resistance heating where the container is heated externally by electric elements. The rationale for developing alternate systems are :

a) Reduction of input energy;

b) Alternate heating sources (gas/oil) when electricity is scarce.

In the first system, the electric elements would be immersed into the bed without increasing the diameter of the chamber which will increase the gas flow considerably (thereby offsetting the energy saving).

The second system is indirect oil heating. The main problem in this system lies in that the sulphur in oil reacts with the nickel in the container and melts it at very low temperatures. Two alternate systems to overcome this would be developed by way of special coatings and another by way of disposable radiant tubes. The third system is of immersed oil heating where an oil/gas burner fires directly into the bed. This system is well known in heating of large chemical vats and swimming pools and would be modified for use in FB furnaces. The fourth and the most significant system is the use of LPG/air mixtues for fluidisation which themselves combust i the bed for heating up. Thus the total electrical energy is expected to reduce by 66% as it is needed only to maintain the bed temperature.

Annexure F

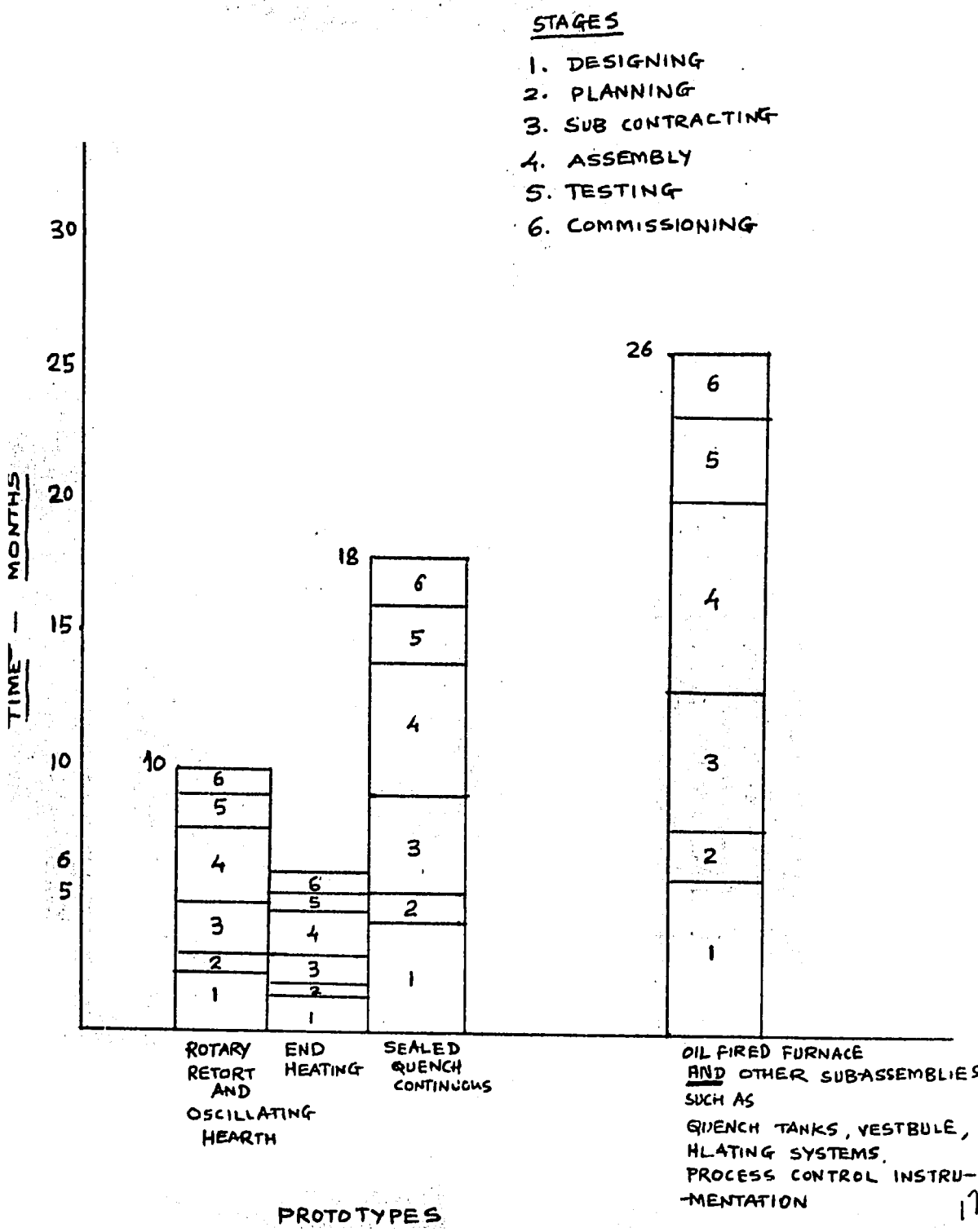
FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(Schedule of Implementation)



Annexure-G

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

(PROJECTIONS OF OPERATING RESULTS)

(Ref. Page 20)

(Rs. in lacs)

		Years after commercialisation			
		(1)	(2)	(3)	(4)
1.	Sales (Quantity) (Nos.)	10	13	18	22
	(Value)	100	150	200	350
2.	Materials, Stores, components	58	87	116	221
3.	Utilities	3	5	6	11
4.	Salaries & wages	3	4	5	6
5.	Repairs & maintenance	1	2	2	4
6.	Factory supervision and Admn. overheads	2	3	6	11
7.	Selling expenses	7	11	14	25
8.	Royalty @ 3% on sales payable to PACER	3	4	6	11
9.	Interest	11	17	16	19
10.	Depreciation	7	10	10	10
11.	Total production cost	95	143	181	328
12.	Operating profit/loss	5	7	19	32
13.	Provision for taxation	1	2	10	17
14.	Profit after taxation	4	5	9	15
15.	Cash accruals (10 + 14)	11	15	19	25

Annexure-H

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,

INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

AND

TI DIAMOND CHAIN LIMITED

STRATEGIC ANALYSIS

(Ref. page No.20)

The success of commercialisation of the technology depends on proper demonstration in the proposed project. It is, therefore, essential to assess the probability of successful commercialisation through analysis of various factors. We provide analysis of 6 such factors each from two catagories relating to (a) the type of business (b) fitness of consortium to take up the project.

A. BUSINESS ATTRACTIVENESS

1. Sales/profit Potential

The internal rate of return works out to about 21% and the proposed project would contribute significantly to the profit of the company. 8/10

2. Growth Rate

Considering growth in automobile industry and ancillary industries as also indigenisation program of various automobile manufacturers growth rate of 12-15% is expected for heat treatment furnces. 7/10

3. Competitor Analysis

FTPL would be pioneer in commercialising the continuous FB furnaces in the country. At present FTPL is the only manufacturer of FB furnaces. It will, however face competition from conventional furnace manufacturers as also new FB furnace manufacturers, and hence FTPL will have to make extra efforts for marketing. 6/10

4. Opportunity to Restructure the Industry

FTPL has already made significant progress in marketing FB furnaces (Batch type) and will have dominant position in the market for FB furnaces. FTPL will have good opportunity to price other entrants in FB furnace market. 6/10

5. Risk Distribution

Development of continuous FB furnaces would lead to possibility of developing a set of new applications of these furnaces as also other types of appliances (eg. wire annealing furnaces). 7/10

6. Special Factors

At present FB furnaces are categorised as energy saving devices and are exempt from sales tax and are eligible for 100% depreciation. 8/10

42/60

B. CONSORTIUM STRENGTH (OR FIT) FACTORS

1. Capital Requirements

FB furnaces are mainly fabricated and then assembled. Fabrication work is generally carried out through vendors. Manufacture of continuous FB furnaces would not require large investment and can be financed out of FTPL's cash accruals. 7/1

2. Marketing Capability

FTPL has existing set up of marketing with 1 Marketing Manager and 3 Sales Engineers and has representatives in major cities in the country. The existing set would be strengthen to market continuous FB furnaces. 8/10

3. Manufacturing Capability

FTPL has necessary facilities, and skills to manufacture important (key) components of FB furnaces. Other standard parts are made as per requirement through local fabricators. 7/10

4. **Technology Base**

FTPL constantly upgrade its skills in heat treatment procers technology in association with IITM and college of Engineering, Pune and other consultants. 8/10

5. **Raw Materials Availability**

Raw materials required to manufacture FB furnaces include mild steels, alloy steel structural sections (all fabrication items), standard electrical and mechanical components such as solenoid valves, motors, PLCs, etc. which are easily available. 8/10

6. **Skills Availability**

FTPL and IITM both have necessary managerial and technical skills. 7/10

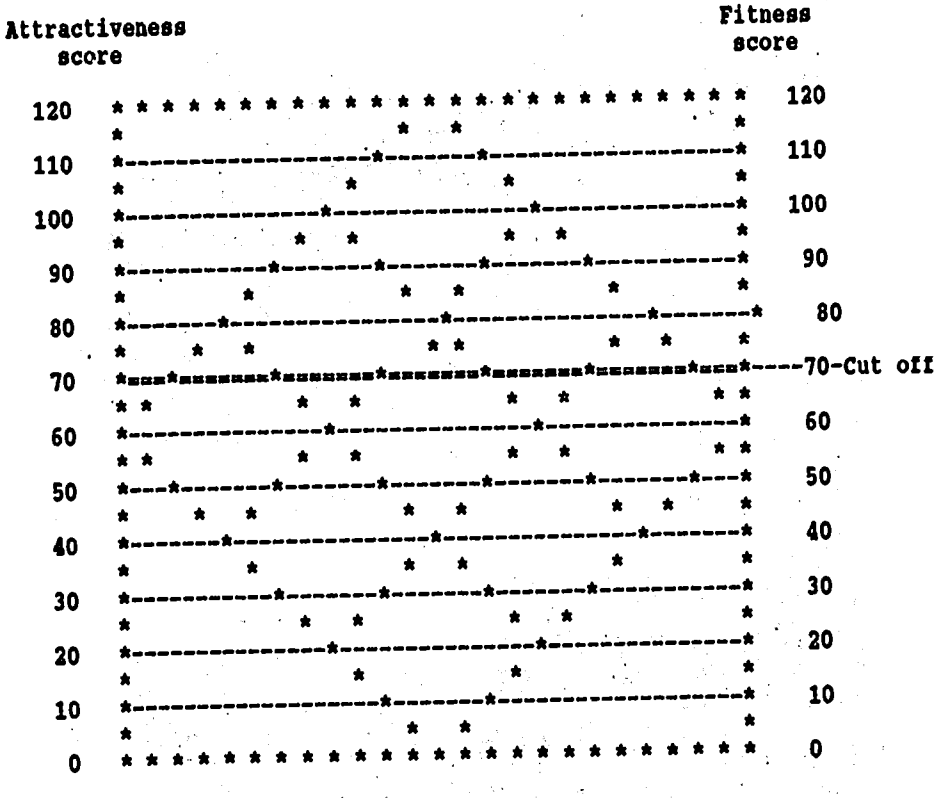
45/60

Total score 87/120

ANNEX H (Contd.)
(Ref. Page 20)

FLUIDTHERM TECHNOLOGY PRIVATE LIMITED,
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS
AND
TI DIMOND CHAIN LIMITED

IDENTITY CHART



A.Business Attractiveness	Pts	B.Consortium Fit	Pts
1.Sales/profit potential	8	1.Capital needs	7
2.Growth rate	7	2.Marketing strength	8
3.Competitor analysis	6	3.Manufacturing strength	7
4.Industry restructure	6	4.Technology base	8
5.Risk distribution	7	5.Raw materials availability	8
6.Specific factors	8	6.Skills availability	7
	42		45

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 3

RESEARCH PROJECT PROPOSAL FOR FINANCIAL ASSISTANCE

	Proposal	Proposer(s)	Project Cost (Rs. lacs)
a)	Research project on optimal utilisation of natural gas in India	I. J. Raju and Associates	4.32
b)	Project for policy on use of Natural gas in Transport Industry	Indira Gandhi Institute Development Research	4.00

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THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITEI

PROGRAM FOR ACCLERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 3 (a

MEMORANDUM FROM PACER SECRETARIAT

ON THE PROPOSAL OF

I.J.RAJU & ASSOCIATES

(Revised Proposal for Research Project)

A research project proposal of I.J. Raju and Associates (IJR), New Delhi on 'optimal utilisation of natural gas in India' was discussed at the second meeting of Peer Review Committee (PRC) held on October 27, 1988. PRC indicated that IJR may submit the revised proposal for the research project explaining the precise scope of the research project in view of the various studies being carried out by Planning Commissioin, ONGC and other government institutions/agencies. Similarly the project should address itself to specific areas keeping in mind the need for identifying appropriate technologies and end users of gas. PRC also indicated that it may be necessary to identify end users of such a research project.

At its 3rd meeting held on March 27, 1989 PRC considered revised proposal of IJR and its comments were as follows :

PRC agreed with recommendation of PACER Secretariat to place the proposal of I.J. Raju and Associates before ERDAC for

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consideration and approval for a suitable amount of grant for the research project on optimal utilisation of natural gas in India, subject to examination of cost of project and scope of the study taking into consideration the time frame of 20 years for projections.

PACER Secretariat subsequently conveyed decision of PRC to IJR as also it held discussions with the consultant. The research project proposal of IJR after incorporating changes keeping in mind observations made by the PRC is now again placed before PRC for its consideration and approval.

IJR, now, proposes to undertake a research project on optimal utilisation of natural gas in India which includes study of factors affecting development of market for use of gas in various sectors and status of technology and capabilities of equipment manufacture for utilisation of natural gas. The projection of availability of natural gas would be worked out with respect to time frame of 20 years. The total cost of the research project is estimated at Rs 4.32 lacs and IJR has requested for grant of an equal amount under the Programme for Acceleration of Commercial Research. We propose to provide IJR a grant of Rs 4.32 lacs out of PACER funds.

BACKGROUND

IJR was promoted in 1987 by I.J.Raju (Raju), a chemical engineer and other professionals for undertaking consultancy assignments and providing advisory services in the fields of management and technology. IJR provides a range of consultancy services including identification of business opportunities,

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techno-economic viability studies, financial management, organisational structure, marketing and distribution, industrial engineering etc.

Raju is a post graduate chemical engineer and fellow of management (IIM, Calcutta) and has professional consultancy experience of over 14 years. Prior to promoting IJR he was General Manager of management consultancy division of S.B. Billimoria & Co. The activities of IJR are carried out by a team of 7 experienced professionals including Raju. IJR also avails services of outside technical experts on project to project basis.

IJR has carried out about 20 consultancy assignments for various organisations in India and abroad. Some of the clients of IJR include Ballarpur Industries Limited, Triveni Engineering Works Ltd., Luz International Inc. USA and World Bank. The assignments carried out by IJR in the area of energy include cost benefit analyses of solar thermal power projects in Punjab and Gujarat, potential and economics of gas turbine in India, market survey for industrial steam turbine, etc. We have gone through some of these studies and are satisfied about IJR's capabilities.

NEED FOR RESEARCH PROJECT

Reserves of natural gas in the country increased rapidly after the discovery of oil and gas in Bombay high. The gas reserves increased almost 16 times from 68 billion cubic metres (bcm) in 1974 to 1,100 bcm in 1988 whereas production of natural gas increased only 7 times from 2,040 million cubic metres (mcm) to 14,400 mcm in the corresponding years.

In the recent years, considerable analysis has been carried out on economics of utilisation of natural gas only in the utility and fertiliser sectors. As a result, government policies for utilisation of natural gas have undergone a gradual transformation. While the priority for use of heavier fractions of natural gas as feed stock for petrochemicals and LPG remains unchanged, the priorities for the use of lean gas (i.e. methane rich gas) which constitutes about 75% by volume of natural gas, have been changed. It is well accepted by now that utility power generation using natural gas as fuel in combined cycle plants is economical option and has high priority. The above change was a result of various studies conducted by Government as well as private agencies. Such studies provide a background for carrying out analyses in other sectors such as transportation, domestic, non utility power generation, co-genration, etc. The need for conducting study by an independent consultant on optimal utilisation of natural gas in India has also been indicated in various seminars.

In view of the above there is a need to carry-out a study on optimal utilisation of natural gas with respect to various parameters which include a) possibility of utilisation of natural gas in different sectors apart from utility and fertilizers, b) availability of new reserves of gas and depletion of gas after use in the next few years, c) evaluation of alternatives for local utilisation against transmission of gas, d) economic cost-benefit analysis and e) identification of technologies required for use of natural gas. The need for such study has primarily been felt because of certain drawbacks in the methodologies of earlier gas utilisation studies and improper assessment of economic value of gas.

PROPOSAL

IJR earlier, in September 1988, submitted proposal to conduct a research project on optimal utilisation of natural gas in India. The scope of the research project envisaged in the original proposal included review of availability of gas over the next 10-15 years, identification of extent of potential use of gas in various sectors, developing methodology for economic cost-benefit analysis, analysis of economics of utilisation and conducting sensitivity analysis of optimal utilisation pattern. The proposal was discussed at the second meeting of the PRC held on October 27, 1988. The comments of PRC on the proposed IJR were as follows :

(1) It would be necessary to collect more information about similar studiies being conducted in other organisations such as ONGC, Planning Commission etc.

(2) The study should address itself to specific areas keeping in mind the need for identifying appropriate technologies and end users of gas.

(3) Though such a study by a private consultant could be useful, it would be necessary to reformulate its scope and ascertain properly the methodology to be adopted and also possible users of the study.

PRC directed PACER Secretariat to discuss the proposal with the proposer and place before the next PRC, the revised version in the light of the above observations.

Accordingly, IJR submitted a revised proposal to undertake research project on optimal utilisation of natural gas

in India. The scope of the revised research project also includes, in addition to the scope envisaged in original proposal, analyses of impediments to development of commercial markets for use of gas in non-utility power generation, co-generation, industrial, transport and domestic sectors, analyses of capabilities of indigenous technology and equipment manufacture for use of natural gas in above sectors based on detailed field survey including study of managements' attitude for such use, analyses of investment required to develop gas markets in the above decentralised sectors.

As indicated at 3rd PRC meeting the projections of availability of natural gas as also other estimates would be worked out with respect to time frame of 20 years.

The research project would be carried out in one phase as against in two phases as envisaged earlier. The project involves substantial increase in field work from 22 man days to 90 man days and would cover about 100 different organisations instead of 26. The research project is expected to require 145 man days of the project leader and 230 man days of a consultant. The project would be conducted within 6 months after its commencement and draft report would be presented at a workshop to be organised as part of the project. IJR would submit final report 1 month after receipt of comments on draft report. A steering committee may be set up to finalise the exact scope of the project, detailed methodology and planning of the study, to review the progress of the project and to discuss and finalise the draft report. Annexure A provides data on the revised research project proposal.

The total cost of undertaking the research project is estimated at Rs 4.32 lacs which includes professional fee of Rs 3.17 lacs and out of pocket expenses of Rs 1.15 lacs. The details of the estimates of costs are provided in Annexure - B.

The terms of reference indicating scope of the project, schedule of assignment, compensaton etc. for undertaking the project are given in Annexure C.

The outcome of the research project is expected to be used as an input for discussions and formulation of policies on utilisation of natural gas in future. The report on the project may be useful to various government agencies, ONGC, GAIL, and various industry associations such as FICCI, ASSOCHAM, CEI etc. The report based on the research project is expected to provide basis for debate and analysis on the subject.

RECOMMENDATION

We recommend to provide IJR a grant of Rs 4.32 lacs out of PACER Funds to undertake the research project on optimal utilisation of natural gas in India.. The project would be carried out as per the Terms of Reference mentioned in Annexure C.

Annexure - A

I. J. RAJU & ASSOCIATES

Data on the Revised proposal to conduct research project on optimal utilisation of natural gas

	Revise
Man-days efforts	
- Project leader	145
- Consultants	230
Total time required (weeks)	24
No. of organisations to be contacted	100
Manpower requirement	
- Project leader	1
- Consultants	2
Total cost of research project : (Rs)	
- Professional fee	3,17,000
- workshop and out of pocket expenses	1,15,000
Total	4,32,000

Annexure - B

I. J. RAJU & ASSOCIATES

(Details of Cost Estimates)

A. **Man-Day Costs**

	Estimated Man-Days	
	Project Leader	Consultant
° Detailed planning of the study (Delhi)	3	6
° Initial discussion with PACER Secretariat (Bombay)	2	2
° Secondary Research		
- Delhi	8	15
- Outside Delhi (Dehradun, Bombay)	2	5
° Development of Methodology & Framework for Economic Analysis (Delhi)	10	10
° Collection of Technical & Cost Data and Discussions with the various Organisations & Field Survey		
- Delhi	10	20
- Outside Delhi	20	40
(Bombay, Ahmedabad, Baroda, Madras, Rajahmundry, Hyderabad, Kanpur, Dehradun, etc.) (60 interviews by a team of 2 persons)		
° Data Analysis (Delhi)	20	40
° Draft Report Preparation (Delhi)	10	20
° Discussion & Presentation of Draft Report (Delhi/Bombay)	5	10
° Additional Analysis (Delhi)	10	15
° Report Finalisation (Delhi)	5	12
° Contingencies (Delhi/Others)	15	30
° Project Coordination (Delhi)	10	-

Proposal Preparation & Pre-study effort	(Delhi)	15	5
Total	(Delhi)	115	180
	(Outside Delhi)	30	50
	(Total)	145	230

Man-Day Costs

	Man-days	Man-day rate Rs.	Cost Rs.
Project Leader	145	1000	145000
Consultant	230	750	172500
		Total Rs.	317500
		Say	Rs. 317000/-

(Though our man-day rates were revised upwards from April 89, we are using the same rates as indicated by us in our original proposal of September 1988 and thus this study will be carried out by us on cost basis without any profit margins because of our interest in this subject).

B. **Out-of-Pocket Expenses**

i) Travel Cost

	No. of man visits	Cost Rs.
Visits to Bombay for discussions with ICICI during the study & secondary Data Collection	4	10,000
Travel for Data Collection & Discussions during field survey		
- Dehradun	2	1,000
- Bombay/Ahmedabad/Baroda	2	7,000
- Madras/Rajahmundry/Hyderabad	2	8,000
- Kanpur/Lucknow	2	2,000
- Others	2	3,000
		31,000
	Say	Rs. 30,000

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ii) Out Station Stay Cost

	No. of man days of oustation stay	Cost Rs.
° Visits for Bombay for meeting with ICICI	4	
° Field Survey outside Delhi (60 interviews @ 2 interviews per day by a team of 2 consultants)	60	
° Secondary Data Collection outside Delhi	7	
° Discussion of Draft Report at Bombay	5	
° Others & Contingency	4	
Total	80	
Average cost of stay per man day stayed outside Delhi (Lodging, Boarding, Conveyance etc.)	Rs. 600 per man day	
Total cost of outstation stay		48,000

iii) Local conveyance in Delhi including visits to Ghaziabad, Faridabad etc.
Rs. 800 per man month x 12-1/2 man months 10,000

iv) Report Preparation (5 copies of Draft Report & 10 copies of Final Report)

° Typing	Rs. 4,000/-	
° Photostat & Binding	Rs. 3,000/-	
° Presentation Material	Rs. 3,000/-	10,000

v) Computer Time 10,000

vi) Miscellaneous (Telex, STD Telephone, Books etc.). 7,000

Total Rs. 1,15,000

C. **TOTAL COST (Man-day Costs & Out-of-Pocket Expenses)**

		Rs.	Rs.
A.	Man-day Costs		3,17,000
B.	Out of Pocket Expenses		
i)	Outstation Travel costs	30,000/-	
ii)	Outstation stay cost	48,000/-	
iii)	Local Conveyance	10,000/-	
iv)	Report Preparation	10,000/-	
v)	Computer Time	10,000/-	
vi)	Miscellaneous	7,000/-	
			1,15,000
		Total (A & B)	Rs. 4,32,000

(Rupees Four lakh thirty two thousand only)

J. T. Rai

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Annexure - C

C

I. J. RAJU & ASSOCIATES

Terms of Reference for undertaking the research project on optimal utilisation of natural gas in India

1. Scope of the research project:

The consultants (IJR) would carry out the project and prepare a report incorporating following aspects:

i) Review of availability of natural gas in the next 20 years and indicate locations of gas reserves. This review would include aspects such as present and future availability of gas in the country, present commitments of gas, present and proposed netwrok for transmission and distribution of gas, compositions and calorific values of gas from various parts of the country, availability of lean gas after extracting LPG and petrochemical feed stocks and transportation costs of gas.

ii) Identify the extent of potential use of gas in various sectors. This would call for review of likely demand for gas for installed capacities of various possible user sectors, production technologies available with user sectors to use gas, availability of alternative feedstock, feasibility and hence potential for use of gas in user sectors.

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iii) Economic analysis including evaluation of extent to which the output of the user sectors are tradeable or non-tradeable, devising methodology to arrive at economic values of gas use in various sectors, working out economic cost from the nation's point of view, study of trends in international prices of gas and other fuels, study of life-cycle economic costs of alternative methods of production in various user sectors working out imputed economic values of gas in user sectors, cost of transmission and distribution, arriving at economic policy for utilisation of gas and sensitivity analysis and study of cost associated with development of a national gas grid. The economic analysis would also focus on likely scenario of gas fields and transmission net-works.

2. **Schedule of assignment:**

The consultants would submit the draft report within 6 months after receipt of sanction letter. The draft report would be presented at a workshop to be organised as part of the project. Final report would be submitted 1 month after receipt of comments on draft report from PACER Secretariat.

3. **Copies of the report:**

The consultants would submit 10 copies of the draft report and 10 copies of the final report.

4. **Compensation:**

The consultants would charge a sum of Rs 1,72,500 towards compensation for undertaking the study.

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Schedule of Payment

-Upto 50% of the total compensation would be payable at the time of commencement of the project.

-Upto 80% of the total compensation would be payable on submission of draft report to the satisfaction of ICICI (Interim disbursements may be considered based on the progress reports submitted by the consultants)

- balance 20% of the total compensation would be payable on submission of final report to the satisfation of ICICI.

5. In the event of IJR not being able to complete the project or abandoning it for any reason whatsoever, all the data collected by IJR shall be handed over to ICICI.

6.(a) Any publication of data or other information derived from the work hereunder, or any publication related to the work, whall contain the following legend or its approved equivalent :

"the work on which this (Article/Publication) is based was supported by a grant from ICICI pursuant to the Agreement between ICICI and United States of America for Program for Acceleration of Commercial Energy Research. The views and information contained herein are those of the authors land not necessarily those of ICICI. ICICI

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assume no liability for the contents of this document by virtue of the support given."

(b) Should ICICI agree to IJR making available copies of the Report to third parties at a price, the sale proceeds thereof would be shared between IJR and ICICI on mutually agreed terms.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

5th PRC Meeting

August 22, 1989

Confidential

Agenda Item 3(b)

MEMORANDUM FROM PACER SECRETARIAT ON THE PROPOSAL OF INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

(Proposal for Research Project)

Indira Gandhi Institute of Development Research (IGIDR), Goregaon, Bombay, set up by the Reserve Bank of India (RBI) conducts studies on various issues of significance to economic development. IGIDR proposes to undertake a research project on fuel substitution by natural gas in the transport sector. The total cost of the research project is estimated at Rs.4 lacs and IGIDR has requested for a grant of equal amount under the Program for Acceleration of Commercial Energy Research (PACER). We propose to provide IGIDR a grant of Rs. 4 lacs out of funds available under PACER.

BACKGROUND

IGIDR, a registered society set up by RBI in 1987, as part of the commemoration of RBI's golden jubilee, for the study of issues relating to economic development aims at promoting the

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study of and conducting research on development (its economic, technological, social, political and ecological aspects) with a broad perspective, to gain insight into the process of development and alternative policy options.

IGIDR is located at Goregaon, a western suburb of Bombay, on a 14 acre site. The institute`s campus is spacious and impressive. It consists of office buildings for research and administrative staff, seminar rooms of different seating capacities, an auditorium with 500 seats, a library, a computer centre, a cafetaria and housing for staff. The campus also has a guest house cum hostel for visiting scholars and students. IGIDR`s library has a collection of over 4,500 books and it subscribes to about 200 periodicals/journals. The institute has 11 personal computers and a mini computer at its computer centre.

IGIDR`s Governing Council comprises eminent experts with Shri R.N. Malhotra, Governor, RBI as chairman. Annexure - A provides a list of members of the Governing Council of the institute. The activities of the IGIDR are carried out by about 20 faculty members, 7 Research assistants and about 15 supporting staff under the guidance of its Director, Dr. Kirit Parikh. Dr. Kirit Parikh is a post graduate in civil engineering from IIT Kharagpur and has a doctorate in the subject from Massachusetts Institute of Technology, USA. He has a wide research and academic experience in the fields of Energy, water, agriculture studies, development policy, food, planning models and technology policies.

IGIDR has carried out research mainly in the areas of methods of planning, alternative strategies of development, food policy, energy systems studies, and technology assessment. The Institute conducted a seminar on applications of high temperature superconductors in power sector in July 1988. Under energy systems studies IGIDR is pursuing research in following fields:

a) Energy conservation

b) Oil and natural gas model for India

c) Technology assessment of application of superconductivity in power sector

d) Rural energy, national grid and power system

NEED FOR THE RESEARCH PROJECT

India, like many other oil importing developing countries, is facing the problem of maintaining a delicate balance between pressing needs of meeting the necessary energy requirements of different sectors of economy and maintaining a healthy desirable balance of payment position of the country. The single largest factor disturbing the balancing act has been the increasing imports of crude oil and middle distillates. The experience of the last decade suggests that a well conceived sectoral approach which may logically fit into the matrix of overall strategy to mitigating the problem could prove to be effective in terms of both time and cost.

Share of middle distillates particularly diesel in the total consumption of petroleum products is about 40%. A study indicates that consumption of middle distillates would grow to about 70% by the turn of the millennium. With 10% growth in heavy traffic, the transport sector alone is expected to constitute about 80% of diesel consumption.

The recent trends in discoveries of oil/gas indicate that increasing quantitites of natural gas resources are struck. Natural gas has emerged as a viable substitute for different petroleum products in various sectors. It is contemplated that compressed natural gas (CNG) can probably be a feasible substitute fuel for diesel in transport sector which forms a major bulk of middle distillates now being consumed in India.

Systematic studies, which could indicate potential for and mechanics of substitution of fuel by natural gas in transport sector along with plan of action and related resource requirements, have not been carried out in the country. Thus there is need for such a study which would provide Government with the policy guidelines and information on the role of various agencies on the one hand and identify infrastructural requirements.

RESEARCH PROJECT PROPOSAL :

IGIDR proposes to undertake research project on fuel substitution by natural gas in transport sector. The main objectives of the project are

a) to examine economic feasibility and extent of substitution of petroleum based fuels in transport sector by natural gas;

b) to analyse various policy options to achieve desired level of substitution of petroleum fuels; and

c) to prepare detailed plan of action to achieve the desired results indicated by the research project.

The research project would identify potential for substitution of fuel in transport sector under different sets of domestic and international environments on account of variations in oil prices, refinery margins, user habits etc. The project would also identify policies which would lead to a desired level of substitution. The research project would bring out various infrastructural requirements such as feeder pipe lines, fuelling stations and investment needed as also environmental effects after introduction of vehicles using Compressed Natural Gas (CNG) as fuel.

The major steps involved in the project are as follows :

a) Development of theoretical framework for the study;

b) Data collection and processing;

c) Surveys and lab tests, if necessary;

d) Analysis and report preparation; and

e) Preparatory work for consortium projects.

All the activities except laboratory tests and surveys would be carried out at IGIDR. The laboratory tests and surveys may be needed to measure pollutants from natural gas vis-a-vis conventional fuels, vehicle movements, user habits etc. and the same would be carried out at other established laboratories.

The research project wouldalso involve interactions with various agencies like Planning Commission, ONGC, GAIL, etc. dealing in natural gas, government departments and experts in this area for technical consultations.

The research project would be carried out by 1 research fellow and 3 other research associates under the overall guidance of Dr. Jyoti Parikh, Senior Professor and co-ordinator of Energy Systems Studies and Technology Assessment. Dr. Jyoti Parikh is a post graduate in physics and has Ph.D. in the field from University of Maryland , College Park, USA. She has vast resea.ch experience in energy modelling, technology and

environment. She has worked at the International Institute of Applied Systems Analysis for about 8 years on energy problems of the developing countries. She has also developed Energy demand model for India for the Planning Commission. She has also served as a consultant to various international agencies such as the US Dept. of Energy, EEC, UNIDO, UNESCO etc.

The research project is expected to lead to development of a suitable consortium R&D project related to CNG based automotive system. IGIDR would identify suitable members of consortium for the R&D project. The proposers would present its draft report on the research project at a workshop to be organised within the scope of this proposal. The probable participants at the workshop would comprise representatives from Planning Commission, Ministries of Petroleum and Industry, ONGC, GAIL, DNES, PCRA, vehicle manufacturers, etc.

The proposed research project would be completed within 12 months after its commencement. A bar chart indicating major steps involved and time required for each step is provided in Annexure - B. The terms of reference indicating scope of the research project, schedule of assignment, compensation etc. for undertaking the project are provided in Annexure - C.

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The total cost of the research project is estimated at Rs. 4 lacs as follows :

	(Rs in 000's)
Salaries and wages	100
Travel and communication	80
Data processing	20
External consultants and Laboratory tests	80
Literature, Journals etc	30
Workshop expenses	25
Administrative overheads	65
	400

IGIDR has requested for grant of Rs. 4 lacs under PACER.

RECOMMENDATION

IGIDR is a reputed development research institute promoted by RBI, conducting research in the areas of policy analysis, strategies of development, energy systems, technology assessment, etc. The proposed research project is expected to lead to formulation of consortium R&D project for utilisation of natural gas as fuel in transport and industry sectors, which in turn can revolutionalise these sectors.

We recommend to provide IGIDR a grant of Rs. 4 lacs out of funds available under PACER to undertake research project on fuel substitution by natural gas in transport sector as per the terms of reference mentioned in the Annexure - C.

Annexure - A

INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

(Members of the Governing Council)

Chairman

Shri R.N. Malhotra
Governor
Reserve Bank of India

Members

Dr. Sukhamoy Chakravarty
Chairman, Economic Council
Government of India
Professor
Delhi School Economics

Dr. M.S. Gore
Professor
Tata Institute of Social Sciences

Dr. P.K. Iyengar
Director
Bhabha Atomic Research Centre

Dr. D. T. Lakdawala
Director, Sardar Patel Institute for Economic Research
Director
Center for Maintaining Indian Economy

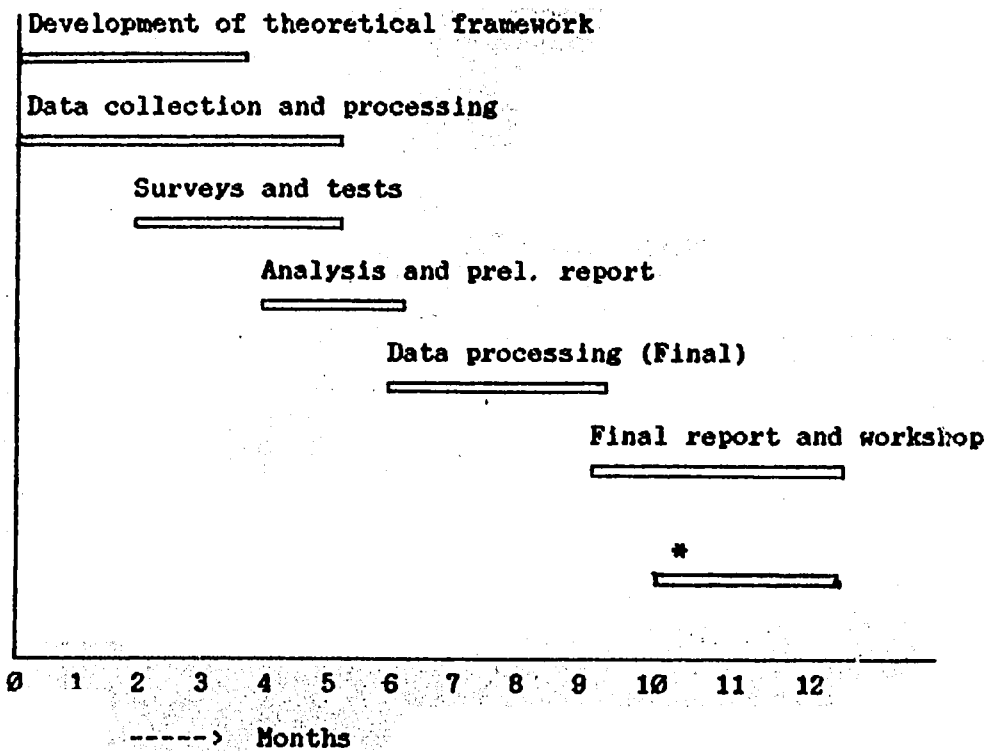
Dr. Kiirit Parikh
Director
Indira Gandhi Institute of Development Research

Dr C. Rangarajan
Deputy Governor
Reserve Bank of India

Annexure - B

INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

(Bar chart indicating steps involved and time required)



Bar Chart for the Research Study Project

*Identifying R & D Consortium/prep. work for Consortium project.

Annexure - C

INDIRA GANDHI INSTITUTE FOR DEVELOPMENT RESEARCH

Terms of reference for undertaking research project on fuel substitution by natural gas in transport sector

1. Scope of the Project

Indira Gandhi Institute for Development Research (IGIDR) would carry out the research project on the following broad guidelines:

a. Examine economic feasibility and extent of substitution of petroleum based fuels in transport sector by natural gas, under different sets of domestic and international environments on account of variations in oil prices, refinery margins, user habits, etc. ;

b. Identify and analyse policy options to achieve desired level of substitution of petroleum fuels by natural gas;

c. Identify various details of infrastructural requirements like feeder pipe lines, fuelling stations and investment needed;

d. Conduct study of environmental effects after introduction of vechicles using Compressed Natural Gas (CNG); and

e. Organise a workshop whereat the draft report would be presented and discussed before preparation of final report.

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Final recommendations would be in the nature of report which would include detailed plan of action to achieve the desired results indicated by findings from above. IGIDR would also identify a consortium R&D project alongwith proposed members of consortium.

2. Schedule of Assignment

IGIDR would submit draft report one year after commencement of the project. After incorporating suggestions made by ICICI, IGIDR would provide final report within 3 months after receipt of comments from ICICI.

3. Copies of Report

IGIDR would submit 10 copies each of draft report and the final report.

4. Assistance

ICICI would provide a grant of Rs 4 lacs to IGIDR for undertaking the project and prepare the reports. IGIDR would bear any increase in cost of the project.

5. Schedule of Payment

upto 50% of the total grant would be payable at the time of commencement of project.

upto 80% of the total grant would be payable on submission of draft report to the satisfaction of ICICI (interim disbursement may be considered based on the progress made by IGIDR) and

balance grant would be payable on submission of final report to the satisfaction of ICICI.

5. <u>Reporting Requirement</u>

IGIDR would provide quarterly progress reports to ICICI on the lines of the format to be given by ICICI.

6. In the event of IGIDR not being able to complete the project or abandoning it for any reason whatsoever, all the data collected by IGIDR shall be handed over to ICICI.

7. (a) Any publication of data or other information derived from the work hereunder, or any publication related to the work, shall contain the following legend or its approved equivalent :

"The work on which this (Article/Publication) is based was supported by a grant from ICICI pursuant to the Agreement between ICICI and United States of America for Program for Acceleration of Commercial Energy Research. The views and information contained herein are those of the authors and not necessarily those of ICICI. ICICI assume no liability for the contents of this document by virtue of the support given."

(b) Should ICICI agree to IGIDR making available copies of the Report to third parties at a price, the sale proceeds thereof would be shared between IGIDR and ICICI on mutually agreed terms.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH (PACER)

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August 22, 1989

Confidential

Agenda Item 4

PROFILES OF RESEARCH PROPOSALS

	Proposal	Proposer(s)	Project Cost (Rs lacs)
a)	Programme for inter-radiation of planters and energy researchers.	Tata Energy Research Institute	5.70
b)	Technology options for Solar Thermal Systems in India	Dr. Rao Associates	25.00
c)	Estimation of export demand potential for Renewable sources of energy in the developing countries	Andhra University	56.00
d)	A Study to further/ promote aims and objectives of PACER	Shri S. Datta Advisor/consultant	1.25

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Agenda Item 4(a)

1)	Proposer	Tata Energy Research Institute 7, Jor bagh New Delhi 110 003 TLX : 031 61593 Phone : 619205, 615032, 690503 Gram : TERINST 110 003
2)	Name of the contact person	Smt. Nalini Ranganathan Information services
3)	Information on current operation	Tata Energy Research Institute (TERI) is a research institute working in all areas of energy including renewables, biotechnology, Rural energy. TERI conducts research studies to evolve/suggest policies to the government also. It conducts training programmes for government officials on energy subjects. It also runs training programmes on behalf of UNESCO, UNESCAP, EEC etc. It undertakes projects sponsored by organisations such as DNES, DST, EEC etc.

4) Information on Research Proposal

a)	Project title :	Programme for Interaction of Planters and Energy Researchers (PIPER)
b)	Scope of the project:	The proposal envisages formation of a network (PEN) which would organise seminars/conventions, publish newsletter covering areas of new energy technologies; organise field trials of selected equipment/systems developed by research institution etc.
c)	Innovative content :	The plantations use large amount of energy and at the same time waste a lot of biomass residues. The planters are not

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aware of new technologies for proper utilisation of energy as well as in the field of plantation practices. The proposed project would pave way for the interaction.

d) Significance of the project

Plantations of cardamom, tea, coffee, tobacco, cashew, coconut arikenut need energy for various operations such as drying. Use of energy-efficient drying, wood/biomass gasification, solar air heating which are under research in various institutions is likely to result in significant saving of energy. The proposed project aims at increasing the interaction of planters and energy researchers.

e) Present status

Planters are using coal and wood as sources of energy and the huge amounts of residues from plantation contributes largely to the pollution. Whereas the research institutions do not have live experience and data for testing of the equipments developed due to lack of linkages.

f) Major steps involved :

(1) Formation of a network for effective interaction among the planters
(2) Publication of newsletter covering areas of new energy technologies common to researchers and planters.
(3) Organisation of seminars/conventions on regional national and international levels.
(4) Information and product exchange with other countries.
(5) Organisation of field trials of selected equipment/systems developed by research institution at selected plantation.

g) Cost of project

Rs. 5.70 lacs

h) Duration

3 years

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Comments : (1) Proposers have mentioned that Planters Energy Network has been existing for two years at Bodhinayakanur, Tamilnadu. TERI has started publishing the news-letter.

(2) It appears that out of project cost of Rs. 5.70 lac, Rs.3.70 lac has been already incurred.

(3) The proposal does not appear supportworthy.

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Agenda Item 4(b)

1. Proposer - name, address, telex and telephone	:	Dr. Rao Associates (DRA) Plot 30, Road 5, Jubilee Hills Society Hyderbad 500 034 AP Telex: 0425-6444 Phone: 238892 Grams: DOCRAO
2. Name and designation of contact person for the proposed research proposal		Dr. M. Ramakrishna Rao Chief Consultant
3. Information on current operations		DRA, established in 1986, is a registered consultancy agency in non-conventional energy sources and instrumentation. DRA undertakes preparation of project reports, feasibility studies, design and organisation of educatinal programmes in science and technology, supply of instruments arrangement for technical collaborations, etc. DRA has carried out in 1986 feasibility studies for establishment of power plants by renewable energy sources in Andhra Pradesh for NEDCAP.
4. Information on Research Proposal	:	
(a) Project title	:	Potential Assessment Identification on technology options and development of commercialisation strategies and plans for solar Thermal Systems in India.

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(b) Scope off the Project	The scope of the project would include following : 1) assessing current status of Solar Thermal Systems in India and elsewhere and the potential existing for exploiting the Solar Thermal Systems; 2) reviewing the existing indigenous technologies, to select appropriate technology and broad specifications for R&D and to indicate plans for commercial production in different parts of the country. 3) developing strategies, plans and programmes for promotion, exploitation, commercialisation and develop promotional packages for popularisation and effective use. 4) helping in conservation of conventional energy, thereby prolonging its availability for putting it to productive use.
(c) Innovative Content	Not indicated
(d) Uses of research	The report based on research project is expected to enable planners, promotional organisations and manufacturers to develop appropriate programmes to tap abundant solar energy and use it within an acceptable cost thereby conserving conventinal energy and using it for more prductive purposes.
(e) Present status	DNES has taken up multidimentional activity for development field demonstration, training and extension of solar Thermal Energy Systems and Devices. The effort of DNES has resulted in popularising the use of low tempera-

ture devices and experimentation of medium and high temperature devices. However, there exists a gap in gathering information pertaining to actual field and end use requirements, the adequacy of the performance data under actual field conditions, strategies and plans to make it commercially viable and implementing the systems in large number as per the requirements of the users.

(f) Major steps involved

1) Current status study
2) Potential survey
3) Identification of technology options
4) Suggesting pilot projects
5) Development of promotional programmes
6) Future strategies, plans and programmes
7) (Details of each steps are provided in the Annexure).

g) Estimated expenditure

Rs 25 lacs, which is made upas under

(Rs in lacs)

Professional Charges	8.40
Cost of surveys & visits	7.30
Data processing	2.90
Purchase of literature and reports	1.00
Organisation of seminars and workshops	2.00
Reports preparation	1.40
Overheads	2.00
	25.00

h) Duration

24 months

i) Project management and control

Project would be carried out by one full time specialist, 2 part time specialists, 4 field officers and 2 supporting staff under overall guidance of Dr. Rao.

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1) Cost of the research project is on much higher side
Scope needs to be defined clearly

2) Impressions of PACER Secretariat on repots prepared by DRA are not satisfactory.

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Annexure

Dr. Rao Associates

(Details of major steps involved)

PHASE - I

CURRENT STATUS STUDY

i) Collection of all information on Solar Thermal Systems and to carry out classification and categorisation (such as smal, medium and large systems).

ii) Collection of relevant information on commercialisation, development, use and its economies of Solar thermal Systems.

iii) Identification of Solar Thermal Systems installed in India in the past, installation plan in the future and collectin of data on its usage, performance and cost benefit.

PHASE II

POTENTIAL SURVEY

i) Carrying out demand survey to identify the potential existing for Solar Thermal Systems.

ii) Identification of Systems and devices where there exists potential for installation of Solar Thermal Systems which will replace the existing conventinal systems or strengthen and support it.

iii) Identification of operational requirements, field conditions and requirements of appropriate Solar Thermal Systems.

PHASE III

IDENTIFICATION OF TECHNOLOGY OPTIONS

i) Identificatin of technlogies available for Solar Thermal Systems.

ii) Carrying out comparative analysis of commercially available Solar Thermal Systems which fits into the requirements as identified under potential survey.

iii) Identificatoin of further development needed in the available Solar Thermal Systems to make it commercially or otherwise viable and usable.

iv) Suggesting necessary design and development to make the Solar Thermal System economically viable for use.

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PHASE IV

SUGGESTIONS FOR PILOT PROJECT

i) Identification of commercially available systems which could be installed under pilot project for performance study.

ii) Suggesting improvements in Solar Thermal Systems and recommending to manufacturing firms to fabricate under pilot project scheme basis.

PHASE V

PLAN FOR COMMERCIALISATION

i) Documenting all designs and development features of improved systems/devices.

ii) Suggesting suitable plans for identifying potential ent repreneurs, training them and helping them to set up industries to manuacture the systems/devices.

iii) Suggesting suitable plans to appropriate authorities for rendering all possible help in manufacturing the system on commercial basis and establishing initial market.

PHASE VI

DEVELOPMENT OF PROMOTIONAL PROGRAMMES

i) Developing suitable Human Resource Development Programme to develop appropriate capabilities to ensure success of the programme.

ii) Developing appropriate programmes to popularise it and make it commercially viable.

iii) Identifying suitable subsidy/grant/loan for adaption by Government Departments/Financial Institutions to promote the Solar Thermal Systems.

PHASE VII

FUTURE STRATEGIES, PLANS AND PROGRAMMES

i) Identifying the plans and programmes under 8th Five Year Plan for Non-Conventional Energy.

ii) Developing a five year plan within the framework of 8th Five Year Plan.

iii) Working out future strategies, plans and programmes for consideration by planners for the future 5 year plans upto 2000 A.D.

iv) Developing Sectorial Plan for Solar Thermal Systems.

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Agenda Item 4 (c)

1. Proposer	Andhra University Waltair 530 003 Tel: 54871, 54572
2. Name and designation of contact person	Dr. K. C. Reddy Professor of Economics Andhra University (Presently Consultant, Research and Information System for the Non-Aligned and Other Developing Countries (RIS) 40-B Lodi Estate New Delhi 110 003)
3. (a) Project Title	Estimation of export demand potential for renewable sources of energy in the developing countries.
(b) Scope of the project	The project envisages study of existing technologies related to renewable sources of energy in the country. Specific items of non-conventional energy would be selected for the purpose of Phase - I of the project. The project would study present availability of resources and adaptability of new technologies. Demand for the new technologies would be estimated, keeping in view the present state of the art, substitution possibiulities with other sources, social adaptability, economics and financial cost, etc.
(c) Innovative content	The project would help in the efficient use of the traditional sources of energy and thus economise their use. At present there is no data on export demand potential for renewable sources of energy in the developing countries.
(d) Use of this research project	The project is expected to make economies of south to achieve collective self-reliance in the field of energy and promote south-south co-operation.

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(e) Present status

The proposer has made selection of products for the study under the proposed project which include (a) improved chullahs, (b) solar cooker/heater and (c) biogas.

(f) Major steps involved

1) Estimate consumption of non-commercial energy

2) Estimation of eneregy imports

3) Estimation of demand for above-mentioned products in 4 selected countries

4) Develop a perspective plan about demand and supply of raw materials, technologies and resources

5) Attempt to identify possible projects and provide co-operation in the form of consultancy.

6) Rs 56 lacs, made up as follows :

	(Rs in lacs)
Salaries and wages	8.0
Data processing	5.0
<u>Travel</u>	
- Within the country	4.0
- Abroad	7.0
Workshops and seminars	8.0
Printing and stationery	2.0
	34.0
Expenses to be incurred in other countries (1US$ = Rs 17)	
Data collection	3.4
Commissioning of projects	5.1
Travel and conveyance	6.8
Other	1.7
	17.0
Total	51.0
Add : 10% overheads	5.0
Grand Total	56.0

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h) Duratioon	18 months
i) Project management	The proposed research project would be carried out by 2 fellows, 4 research associates, 3 research assistants, 1 programmer and 2 supporting staff under the overall guidance of Dr. Reddy.
4. Comments	1) IREDA has indicated its willingness to sponsor/co-sponsor the project 2) Proposer has requested Rs 17 lacs out of Rs 56 lacs in the form of foreign exchange.

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION OF INDIA LIMITED

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Agenda Item 4(d)

1. Proposer's name, address telegram and telephone : Sankaracharyya Datta
Adviser/Consultant
7-D, Ashoka Apartments
111, Southern Avenue
Calcutta 700 029

Telephone No : 423194

2. Name and Designation of contact person : As above. Formerly Chief Executive of Ahmedabad Electricity Co. Ltd. Biodata of S. Datta and his associate B. Bose are enclosed.

3. Information on current operations : N.A.

4. Information on proposal :

a) Project title : A study to further/promote aims and objectives of PACER.

b) Scope of the project :
- To formulate strategies to publicise and popularise the PACER scheme,
- To work out approaches for contacting potential clients for PACER,
- To identify strategies/steps for inducing the genuine researchers and manufacturers to undertake suitable R&D projects qualifying under PACER, and
- To identify the range of equipment and processes within the broad aims of PACER with a priority list which might evoke easy response from the potential developers.

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c) Significance of research project

The study might help focussing the efforts of PACER Secretariat in operating the scheme more effectively.

d) Present status

S. Datta has only conceptualised the study proposal at present.

e) Major steps involved :

(i) Prepare a structured questionnaire for researchers, manufacturers and end users in the country.

(ii) After receiving responses on the basis of the above questionnaire, classify the information suitably.

(iii) Conduct interviews with a representative cross section of the above respondents.

(iv) Derive inferences in relation to the scope of the study project.

(v) Prepare the study report.

f) Cost of the research project :

	(Rs lacs)
Fees for the consultants/associates	0.80
Travelling, boarding/ lodging and interviewing expenses	0.45
Total	1.25

g) Duration

About 4 months

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S. Datta
ADVISOR/CONSULTANT

Bio-data

Name : Sankaracharyya Datta

:

Address :

Telephone :

Education (academic and professional) :

B.Sc.; Bachelor of Electrical Engg. (Jadavpur); Chartered Engineer & Fellow of the Institution of Electrical Engineers (U.K.); Certificate of Industrial Engineering awarded by North-Eastern County Education Board of U.K.

Training :

Two years post-graduate practical training with C.A. Parsons (now NEI Parsons) of U.K. on manufacture, factory assembly and test and site erection and commissioning of large-sized turbo-generators and auxiliaries. Also, three months practical training with A. Reyrolle of U.K. on assembly and test of high voltage switchgear of all types prevalent in the 1950s and protective relays.

Attended the following courses :

(1) 3-Tier Senior Executive Programme on Management Development conducted by the Indian Institute of Management, Ahmedabad;

(2) Finance for non-financial Executives conducted by Administrative Staff College, Hyderabad;

(3) Management by Objective conducted by Administrative Staff College, Hyderabad;

(4) Organisation Development and Organisation Change conducted by Administrative Staff College, Hyderabad.

Industrial and Business Experience :

1955-57 - Assistant Engineer in product development engineering with C.A. Parson, U.K. in Electrical Research Dept.

1957-85 - With the Managing Agents of Ahmedabad Electricity Co., Ltd. (1957-61) and with the Ahmedabad Electricity Co. Ltd. (1962-85) in various capacities till retirement in June 1985.

1957-61 - With Killick Industries Ltd. (Mg. Agents of Ahmedabad Electricity Co. Ltd., Bombay Suburban Electric Supply Ltd. and Surat Electricity Co. Ltd.)

As Convenanted Assistant was responsible for :

(i) appraisal of capital development schemes on generation, transmission and distribution of the three electricity companies for feasibility, economic viability and phasing of proposed investment and resource allocation;

(ii) assist in short-term and long-term finance raising and cash management;

(iii) study and assist in formulation of annual capital and revenue budgets, review and formulation of personnel policies; and

(iv) study and assist in formulation of electricity tariff proposals of the undertakings vis-a-vis profitable operation for three forward years.

1962-71 : As Head of an independent Administration Dept. of Ahmedabad Electricity Co. Ltd. (AEC) at Bombay and Secretary to the Company's Board of Directors was responsible for

(i) review of prevailing policies in dialogue with site management of AEC and evolving considerations for policy changes where necessary and new policy formulation where none coded before, in all aspects of Company management that require Board's approval prior to implementation. This embraced areas of human resources, financial resources, relations with the Central Government and Gujarat State Government, tariffs and related matters;

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(ii) briefing Company's non-executive Chairman on agenda formulation, on important occurrences and their ramifications to the Company, on annual general meetings & Chairman's review to members;.

(iii) liaison with Managing Agents (till March 1970) on matters pertaining to finance raising.

1971-85 : Posted to and operated from site i.e. Ahmedabad as : the single Deputy Chief Executive (1971-78); the sole Chief Executive (1978-82) in charge; and in charge of growth areas (1982-85) with the designation of Chief Executive (Projects & Development).

On posting to Ahmedabad from Bombay in 1971 my Objectives were :

(1) to effectuate smooth transition from an agency-managed company to an independently working company under the management of a supervisory Board of Directors where none of the Board-members were whole-time directors of the Company;

(2) to professionalise all services and cadres of the Company for efficient and professional executive management.

Objective (1) was achieved by :

(a) re-defining responsibilities and accountability of the Chief Executive to the Board, delegation of authority to the Chief Executive commensurate with that of an independently functioning company, restructuring organization and re-aligning reporting relationship of executives down the line to the Chief Executive;

(b) creation of adequate infra-structure at site for carrying out the financial responsibilities of an independent company, handling of major legal responsibilities and personnel responsibilities especially in the important area of human resources development, and establish and maintenance of effective liaison with State Government machineries, financial institutions and banking fraternity;

(c) actions initiated in 1972 culminated in the registered office of the Company being transferred to Ahmedabad in 1975.

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Objective (2) essential to the functioning of an independent company subject only to the supervision, control and superintendence of a truly supervisory Board was achieved by :

(i) carefully selecting and inducting a professionally qualified Company Secretary, a Financial Controller and a Personnel Manager and developing and supporting these services by recruitment and staffing their departments with professionally qualified incumbents;

(ii) re-orienting reporting relationship and departmental attitudes inter se the existing departments;

(iii) re-vamping the old Purchase Department to incorporate inspection function and stores control function and re-naming it as Materials Department for wider responsibilities;

(iv) re-grouping the existing major technical departments as Generation Division and Transmission & Distribution Division. Heads of these divisions were encouraged to re-draw their departmental structures to reflect more intensively planning and supervision content of organized group activities with emphasis on co-ordination among groups and readily available support and resources to working groups. Introduction of systems approach in the areas of maintenance and plant management. This has rapidly enhanced the plant availability factor so vital a requirement in the power industry for improved capacity utilisation.

Objectives (1) and (2) were set in 1971. By 1975 Objective (1) was fully realised and Objective (2) was in a highly developed stage for fulfilment. The Company was ripe for further modernization. The logical development of AEC to this satisfactory stage was reflected in its sound financial working. In the power industry it enjoys reputation for consistently high capacity utilisation of 73%-76% year after year against a national average of about 50%. AEC has also won plaudits for successful project management within an earlier set time-limit. The Company, therefore, decided to undertake more projects and diversify its activities based on its inherent strength of trained manpower, professional capabilities and developed management resources.

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As Chief Executive (Projects & Development) from 1982-85 my responsibilities included :

(1) commissioning of a second 110 MW Power Project within a declared target of 42 months; and .

(2) identification, laying the foundation of and developing organization for diversification activities on appropriate lines as distinct business proposition.

Objective (1) was achieved within the target date by organizing all aspects of project management on sound lines, anticipating slippages of all agencies (consultants, manufacturers, sub-contractors, erectors) and evolving timely contingent plans. The twin aims of time-management and cost-management consistent with quality engineering were fully realised. After a minimum teething trouble of three months the availability factor of this newly commissioned Unit rose to over 85%.

For Objective (2) it was recognized that the Company's basic strength lay in its human resources and professional capabilities and the fulfilment of new business should be with least capital outlay and the gestation period shortest. Business potential has, therefore, been identified in rendering following services to the power industry in particular and to the organised process industries also:

(a) Maintenance management services :

Approach, systems and methods of modern and proven maintenance management have been fashioned after those of an U.S. based collaborator, M/s. Catalytic Inc. who have specialised over past 30 years on maintenance management of power and process plants. They have long duration maintenance contracts with power stations in USA, both nuclear and fossil fuel-fired stations and process industries like refineries, petro-chemical complex, fertilizers, etc. in U.S. and abroad.

It is recognized that there is a major need for sound maintenance services organized on modern lines. Therefore, the business of AEC can fill a major gap while realising major business opportunities.

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(b) Power Plant Retrofit and Plant Revamping :

Apart from its own capabilities which have been augmented substantially association has been established with a leading U.S. firm of Architect Engineers in this field as also with a leading consulting engineering firm in India. AEC is also negotiating to acquire the experience of a leading U.S. Power Utility with major coal-based generation stations, who have gone through similar phases as the power industry in India and who by systematic approach have improved their plant availability to over 95% and capacity utilisation (indicated by plant load factor) to over 80%. This specific knowledge, systems and methods are sought to be acquired through a joint venture.

Due to the persistent record of low capacity utilisation year after year the country's power industry, it is anticipated, will welcome sound efforts by reputed and knowledgeable sources who are capable of offering not only diagnostic reportsand recommendations but who can also demonstrate results by implementing its own recommendations. Business potential in this field is substantial. Besides, this type of business also serves to render a timely service to the sorely tried power industry in the country.

(c) Power Project Management :

Based on its own experience and successful management of its own power projects AEC will market this capacity to others undertaking power projects.

From 1963 to 1985 I had been a permanent invitee to AEC Board meets in various capacities viz. Board Secretary, Deputy Chief Executive, the Chief Executive and the Chief Executive (Projects & Development).

On 30th June 1985 I retired from the regular service of the Ahmedabad Electricity Co. Ltd. after 28 years of intimate association with this performance-oriented Utility in the country.

Effective 1st August 1985 AEC retained my services as a part-time Advisor/Consultant in specified fields.

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Other Assignments :

1979-83 - Member State Electricity Gujarat/Consultative Council
An appointment under Cl 16 of the Electricity Supply Act, 1948.

1982-85 - Member, Governing body Gujarat Energy Development Agency, a State level Agency for development of alternate energy in Gujarat State.

1986 - Chaired a State level Committee on Causes for the failure of Distribution Transformers in Gujarat Electricity Board's system.

Member, State Committee on level and requirement of training of technical personnel engaged in the generation of electricity in Gujarat Electricity Board's Power Stations.

1987 to-date - Consultant on the panel of Tata Consulting Engineers. Review of Feasibility Study Reports of Power Projects, preparation of Study Reports on financial and organisational aspects of business incidental to Utility operation.

Consultant to the Confederation of Engineering Industries (Eastern Division) on preparation of a Report on the Energy Policies in India for submission to the Govt of India.

Consultant to Mukand Iron & Steel for a Feasibility Study Report on the business prospects on Power Plant Construction Activities and allied business in India; Assisting Mukand to organise for entry into such business.

Current activities : On organisational aspects of energy conservation work among groups of energy consuming organisations.

Calcutta

(S. Datta)

B.N.BOSE
Consultant

Bio-data

Name	BARINDRA NATH BOSE
Technical Qualifications	Bachelor of Electrical Engineering from University of Calcutta, 1946.
Professional Membership	Fellow of the Institution of Engineers (India); Member Central Board of Irrigation and Power, INDIA.

Professional Experience

1986 - to-date	Consultant to the Central Electricity Authority, Govt of India. Director, Durganur Projects Ltd., a Govt of West Bengal Undertaking with Thermal Power Stations and Coke Oven Plant.
1983 - 1986	Consultant to NEI Projects (India) Ltd., for the establishment of 2 x 500 MW Rihand Super Thermal Power Station.
1981 - 1983	Member (Operation) Central Electricity Authority & Ex Officio Addl Secretary to the Govt of India.
1980 - 1981	Adviser and Head, Projects Engineering Divisopn of Bharat Heavy Electricals Ltd. (BHEL).
1978 - 1979	Member (Generation) U.P. State Electricit Board
1977 - 1978	Chief Engineer (Thermal Construction Monitoring), Central Electricity Authy.
1972 - 1977	General Manager, Kanpur Electricity Supply Administration and Chief Engineer U. P. State Electricity Board. Joined U.P.S.E.B. in 1956 as an Executive Engineer.
1946 - 1948	Graduate Apprentice at Associated Electrical Industries (AEI), U.K.
1948 - 1950	Asst Resident Electrical Engineer, M/S Merz and Mclellan, U.K.
1951 - 1956	Resident Engineer M/S Merz & Mclellan, India

THE INDUSTRIAL CREDIT AND INVESTMENT CORPORATION
OF INDIA LIMITED

PROGRAM FOR ACCELERATION OF COMMERCIAL ENERGY RESEARCH
(PACER)

5th PRC Meeting

August 22, 1989

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Agenda Item 5

Progress of projects under implementation

Note would be placed on Table.

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