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INTERNAL REPORT

International Atomic Energy Agency

and

United Nations Educational Scientific and Cultural Organization

INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS

PHYSICS AND DEVELOPMENT

Winter College on Nuclear Physics and Reactors

25 January - 19 March 1982

LIST OF CONTENTS

INDIA

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Man-Power

In India we have to-day about eighty universities where there are post-graduate departments of physics. These universities may be roughly divided into two categories:

i) Those which have about ten university teachers. By teachers I mean Professors, Readers and Lecturers. The number of such university departments may be around fifty.

ii) Those departments where the number of university teachers in Physics are around twenty or more. The number of such universities are of the order of 25 or so.

The total no. of physics teachers in the universities are of the order of 1200 (30x25 + 50x10 = 750 + 500 = 1250). The approximate number of research students in the universities may be of the order of 1200. Thus we have about 2400 teachers and Ph.D. students in India in the University departments.

Most of the people in the university departments are well trained and many of them have spent many years aborad in good laboratories and have done good work. The total number of post- Ph.D. research workers in physics in all research agencies in India will come to about 500 or so. These agencies include Atomic Energy, C.S.I.R., Space Research etc.

Being a nuclear physicist myself I can talk/ a little more easily on the status of nuclear physics rather than Physics. Also nuclear physics which constitutes the gross-root of the nuclear sciences continues to be the focus of intensive basic research programmes throughout the world. One reason for the intensification of the basic research programmes in the frontiers of nuclear physics may be the hope that it may bring break throughs in the areas of peaceful utilization of nuclear energy. But more important than that is the reason that nuclear physics research continues to be a frontier with emerging new discoveries and sense of excitement.

Out of this about 550 workers (both senior and junior) are in nuclear physics in various institutions in India. Thus the number of research workers in Nuclear Physics are about 18% of the total number. The following categories of branches are included while arriving at this number.

1) Nuclear Theory (NT)
2) Nuclear Reactions (Experimental) (NR)
3) Nuclear Structure (NS)
4) Nuclear Solid State (NSS)
5) Applied Nuclear Physics (ANP)
6) Nuclear Instrumentation (NI)

The approximate distribution of research workers in Nuclear Physics in various institutions in India are given in the following table.

Research Facilities & Work

A beginning was made in early 1960's in the areas of basic nuclear physics with the commissioning of Apsara reactor and 5.5 MeV Van de Graaff accelerator at Trombay. Before that nuclear physics research was mainly on problems in which radiactive sources were used and these were imported from outside. Small accelerators of energy ranging from 150 KeV to few MeV were also installed at some of the universities departments. Over the years the facilities mentioned above have been utilized to their fullest research potential. But unfortunately the nuclear physics research programme of the universities are still based on small accelerators facilities of 1960's and this is leading to a widening of gap between our research efforts and those of international community.

The Department of Atomic Energy of India has completed fabrication of a Variable energy cyclotron at Calcutta and this machine has become operational very recently for nuclear physics experiments. In addition a heavy ion research facility of 14 UD Pelletron has been sanctioned for installation at Tata Institute of Fundamental Research Bombay. This machine will become functional for experimental nuclear physics work in a few years time.

Table 2 gives the particulars of the accelerator facilities available in our country at present. Table 3 gives the reactor facilities available for neutron work at Bhabha Atomic Research Centre.

Some Comments:

The present status of the facilities for nuclear physics research at the universities in rather depressing. As is evident from the previous table the number of accelerators in the university departments are net that insignificant, but none of these are suitable for nuclear physics research programmes at the frontiers. The lack of paper facilities and equipments for experimental work has hampered the use of even these accelerators for meaning research in nuclear physics. The sophistication, energy of the accelerators as and the equipments for experimental work in an order of magnitude lower because of the limited funds available for research at the universities. The university programmes of nuclear sciences have been developed under severe strain of low inputs as well as administrative difficulties. It is for these reasons that most of the universities have developed or purchased only low energy accelerators either meant for fast neutron work or far applied nuclear physics.

Approximate distribution of research workers in nuclear physics in various institutions in India

S.No.	Place	Senior	Junior	Main subjects
1.	Aligarh (Muslim Univ.)	18	19	NS, NSS, NT
2.	Bangalore (Indian Inst. of Science)	4	10	NSS
3.	Bangalore (Bangalore Univ.)	5	6	NS, NSS
4.	Bhuwneshwar (Bhuwneshwar Univ.)	5	6	NT
5.	Bombay (Tata Inst. of Fundamental Research)	10	20	NS, NSS, NT, NI
6.	Bombay (Bhabha Atomic Research Centre)	25	25	NT, NR, NS, NSS, ANP, NI
7.	Bombay (Indian Inst. of Technology)	14	8	NT, NS, ANP
8.	Bombay (Bombay Univ.)	9	15	NSS, NI
9.	Burdwan (Burdwan Univ.)	1		
10.	Calcutta (Saha Inst. of Nuclear Physics)	14	20	NT, NR, NSS, NS, ANP, NI
11.	Calcutta (Variable Energy Cyclotron)	15	15	NR, NS, NI
12.	Calcutta (Bose Inst.)	4	8	NR, NS, NI
13.	Calcutta (Calcutta Univ.)	1	2	
14.	Calicut (Calicut Univ.)	6	10	NSS, NT, NI
15.	Chandigarh (Panjab Univ.)	16	20	NT, NR, NS, NSS, NI, ANP
16.	Delhi (National Physical Lab.)	4	6	NSS
17.	Delhi (Delhi Univ.)	5	4	NSS, NS
18.	Jaipur (Jaipur Univ.)	6	10	NSS
19.	Kanpur (Indian Inst. of Technology)	13	14	NR, NSS, NS, NT, ANP, NI
20.	Kurukshetra (Kurukshetra Univ.)	11	15	NSS, NI, ANP, NS, NT
21.	Madras (Madras Univ.)	5	10	NSS
22.	Patiala (Patiala Univ.)	8	12	NR, NS, NI
23.	Poona (Poona Univ.)	5	10	NSS, NI
24.	Roorkee (Roorkee Univ.)	6	6	NT, NS, NSS
25.	Shilling (NHU) (Shilling Univ.)	1		
26.	Udaipur (Udiapur Univ.)	6	6	NSS, NI
27.	Varanasi (Banaras Hindu Univ.)	10	18	NS, NSS, NI, NT
28.	Waltair (Waltair Univ.)	15	25	NS, NR, NT, NSS, NI
	TOTAL:	224	324	

This list does not include the people using NMR or Mössbauer Technique for chemical studies, or agriculture or geology etc. It only includes people engaged in nuclear physics and nucleo-solid state problems.

ANP = applied nuclear physics,
NI = nuclear instrumentation
NR = nuclear reactions (experimental)
NS = nuclear structure
NSS = nuclear solid state
NT = nuclear theory

Particulars of the Accelerators in Different Institutions in India

		Max.Energy		
1. TIFR, Bombay+	Cockcroft-Walton Accelerator	1 MeV	1956	Imported
2. SINP, Calcutta	-do-	400 KeV	1958	Constructed
3. Bose Institute, Calcutta	-do-	250 KeV	1958	-do-
4. Aligarh Muslim Univ., Aligarh	-do-	150 KeV	1958	-do-
5. BARC, Bombay	Vande-Graaff Accelerator	5 MeV	1960	Imported HVC
6. Dept. of Nuclear Phys. Andhra Univ., Waltair	Cockcroft-Walton Accelerator	800 KeV	1962	Constructed
7. BHU, Varanasi	Vande-Graaff Acc.	400 KeV	1968	Imported HVC
8. Panjabi Univ. Patiala	-do-	400 KeV	1968	-do-
9. IIT, Kanpur	-do-	2 MeV	1970	-do-
10. SINP, Calcutta	Cyclotron	4 MeV	1970	Reassembled and constructed
11. Calcutta Univ. Calcutta	Vande-Graaff Acc.	1 MeV	1970	Under construction.
12. Panjab University, Chandigarh	Variable Energy Cyclotron	2.11 MeV	1977	Reassembled and constructed
13. VEC, Calcutta	-do-	He^4 10 - 130 MeV	1978	Constructed
14. Deptt. of Physics, Calicut Univ. Calicut	Cockcroft-Walton Acc.	1 MeV	1980	Transferred from TIFR
15. Poona University	Electron Acc. (Microtron)	8-10 MeV	1975	Constructed
	Two High Voltage Generators	300 KeV	1978	-do-
16. BARC, Bombay	Tandem Vandegraaff	0.4 MeV	1978	-do-
17. Tata Inst. of Fundamental Research	14UD Pelletron, H'	28 MeV	1984	Basic Unit to be imported

+ Now at Calicut

Activities of Nuclear Physics (Experimental)

In the Fifties, nuclear physics research was mainly confined to Saha Institute of Nuclear Studies, Calcutta, and TIFR, Bombay. This research was mostly confined to nuclear structure and other related problems using radioactive isotopes. Some neutron reaction work was also undertaken in some universities using low-energy accelerators. But an impetus to the basic nuclear physics research was given in the late Fifties and the early Sixties when the "Apsara" reactors was commissioned in BARC and also 5 MeV Van de Graaf accelerator was installed at Trombay.

The experimental nuclear physics work done in India can be broadly divided into three categories:

I) Nuclear structure and other problems using radioactive isotopes;
II) Problems based upon low-energy accelerators;
III) Reactor based problems.

In the first category work has been done on the following:

I) Study of the excited states using

a) coincidence arrangements
b) angular correlation studies (β-γ; γ-γ and γ-γ-γ)
c) perturbed angular correlation studies
d) polarization correlation
e) lifetime measurement studies
f) isospin forbidden beta decay
g) Mössbauer effect studies.

II) Work has been done on the following accelerator based problems:

a) Study of short-lived radioactive isotopes produced by fast neutrons
b) (n,γ), (n,α), ($n,2n$) and (n,p) reaction cross-sections using activation technique at different energies of neutrons
c) study of analogue resonances in the f-p shell nuclei
d) proton induced X-ray studies for analysis of trace elements
e) fission studies in the KeV-MeV region
f) study of nuclear states by Coulomb excitation as well as by (p,γ) and ($p,p'\gamma$) reaction
g) study of proton specta in (n,p) reaction
h) study of resonance reactions like (p,n) and (p,α)
i) one-or two-particle transfer reactions like (He^3,p), (He^3,n) (He^3,α) and (He^3,d).

III) Work has been done on the following reactor based problems:

a) radioactive isotopes production
b) fission studies at thermal energies
c) fission cross-section studies
d) mass asymmetry of the fission fragments
e) angular distribution of fission fragments
f) studies of X-rays emitted in the fission process.

Nuclear Theory

Work on the following problems has been done in nuclear theory:

a) nuclear structure calculations using HF technique as well as nuclear structure calculations connected with back-bending phenomenon
b) fission problems particularly shell effects on the fission of nuclei
c) effective interactions and nuclear many-body problems
d) collective model and nuclear reaction mechanism
e) sum rule methods in transfer reactions
f) core polarization effects in nuclear spectroscopy.

Fall out of the nuclear physics research has been in the following fields:

a) vacuum technology
b) electronics
c) magnets
d) plasma physics
e) control systems
f) solid state devices for detectors
g) logic systems including computers.

Research facilities available at Aligarh Muslim University, Aligarh:

1.	nuclear physics:	experimental theoretical
2.	spectroscopy:	atomic, molecular and laser physics
3.	high energy physics (experimental)	emulsion technique plastic track detectors
4.	solid state physics (experimental)	NMR, EPR, X-rays and Mössbauer.

P A K I S T A N

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Centre For Nuclear Studies, Pakistan Institute of Nuclear Science And Technology, P. O. Nilore, Rawalpindi, Pakistan.

Pakistan won its independence after one hundred years of British rule. It is situated in South Asia bordered by India on the east, Iran and Afganistan on the west, China on the north and the Arabian Sea on the south. The country is the old Indus Valley with its rivers, namely, Jehlum, Chanab, Ravi,and Sutlej. For administrative purposes, the country is divided into four provinces i.e. Punjab, Sind, Baluchistan and North West Frontier Province and federal Government administered areas like federal capital area and tribal areas. Urdu is the national language. There are four regional languages. These are Punjabi, Sindhi, Baluchi and Pushtu. English language is widely spoken and understood.

Pakistan has the biggest artificial irrigation system - some 10,000 miles long canals - irrigating 23 million acres of land. The rivers have been linked through the Link Canal System under the Indus Basin Treaty of 1960. The country has extreme weather conditions both in summer and winter. North is the extreme end of the Himalaya mountains and the west is separated by the Hindu-Kush range which is dry. Some pertinent information about the country is given below:

1. Area and Population: 804,000 Km^2; 83.4 million persons.
2. Urban and Rural Population (%) : 49 and 51 ; Literacy 24%.
3. Crops : (a) wheat, sugar cane, rice, tobacco, cotton, mustard & corn;
   (b) fruits; mangoes, oranges, apples, dry fruit, and so on.
4. Livestock: Cattle, buffalo, camels poultry, horses, sheep, etc
5. Minerals: Petroleum (10% of national needs). coal, gas, cement, salt, limestone, gypsum.
6. Forests: Only 5% of total area.
7. Manufactures: Textile both cotton and wool, chemicals and synthetics, basic metals, sport goods, jute manufactures, electrical goods, sugar, cement,.
8. Imports: Food other than wheat since 1980, crude oil, machinery and metal manufactures, vehicles and parts, chemicals and life saving drugs and medicine.
9. Exports:Raw materials other than petroleum, rice, raw cotton and textile, garments, wool and fabrics, carpets, sport goods, leather and foot wear and so on.

10. <u>Energy Resources</u>: Hydro-Electricity, gas, coal, and petroleum.
11. <u>Means of Communication</u>: Roads, railways and air.
12. <u>Labour Force (%)</u>: Agriculture (46), industry (16), and other services (38).

Pakistan inherited British education system at the time of independence in 1947. There was no science or technical college except one college of engineering and another one of agriculture for a population of nearly 40 million people. Now there are 10 general education universities with science subjects, 5 engineering, 3 agriculture and one medical university. Sixteen years of schooling at different levels, i.e. primary, middle, high, intermediate and graduate levels lead to the award of an M.Sc/M.A., B.Sc. in engineering or MBBS in medical sciences.

There are research organizations like Pakistan Atomic Energy Commission(PAEC), Pakistan Agriculture Research Council, Pakistan Council of Scientific and Industrial Research Organization and many more. Each organization is engaged in research and development of its particular field of interest. PAEC is engaged in research and development of nuclear energy for peaceful uses of the country. PAEC has six medical and two agriculture centres at different places in the country. In addition, one big central medical institute is in the process of completion where latest facilities for medical treatment would be available. For nuclear research and development, PAEC has one big research centre at Rawalpindi known as PINSTECH an abbreviation of Pakistan Institute of Nuclear Science and Technology. The facilities available for research at PINSTECH are 5 MW(t) swimming pool research reactor with six beam tubes, a thermal column, a rabbit system for irradiation and a hot gamma cell with manuplators, a 14 MeV neutron generator, a triple axis diffraction spectrometer, mass spectrometers, electron microscope, heat transfer loop, analogue computer, simulater, computers etc., alongwith support facilities such as workshops, both general and electronics, etc. In addition, PINSTECH has a Centre For Nuclear Studies (CNS) which is engaged in teaching and training at postgraduate level in the field of nuclear

science and technology..CNS conducts a regular 4 semester (each of four-and-a-half) M.Sc.(Nuclear Engineering) course and a number short courses in medical physics, health physics, air-conditioning and so on. CNS is open to students from any country. Participants from Algeria, Libya, Jordan, Iraq, Indonesia, Malaysia have attended our regular course. The degree on successful completion of the course is awarded by Quid-i-Azam University, Islamabad. Pakistan is not

Pakistan is not a developed country and also it is not very rich. It's GNP is only $260 according to the 1981 World Bank Report. It is greater than GNP of all countries of all countries in the region, namely, Bangladesh, Burma, Nepal, India, Sri-Lanka and Afganistan. China's GNP is also $260. Pakistan's manpower has a great potential for its future. Professor Abdus Salam, Director of the International Centre for Theoretical Physics, Trieste, Italy is one of the obvious examples. Hopefully, there would be many more from Pakistan to follow his footsteps in the future in the field of physics and development.

I N D O N E S I A

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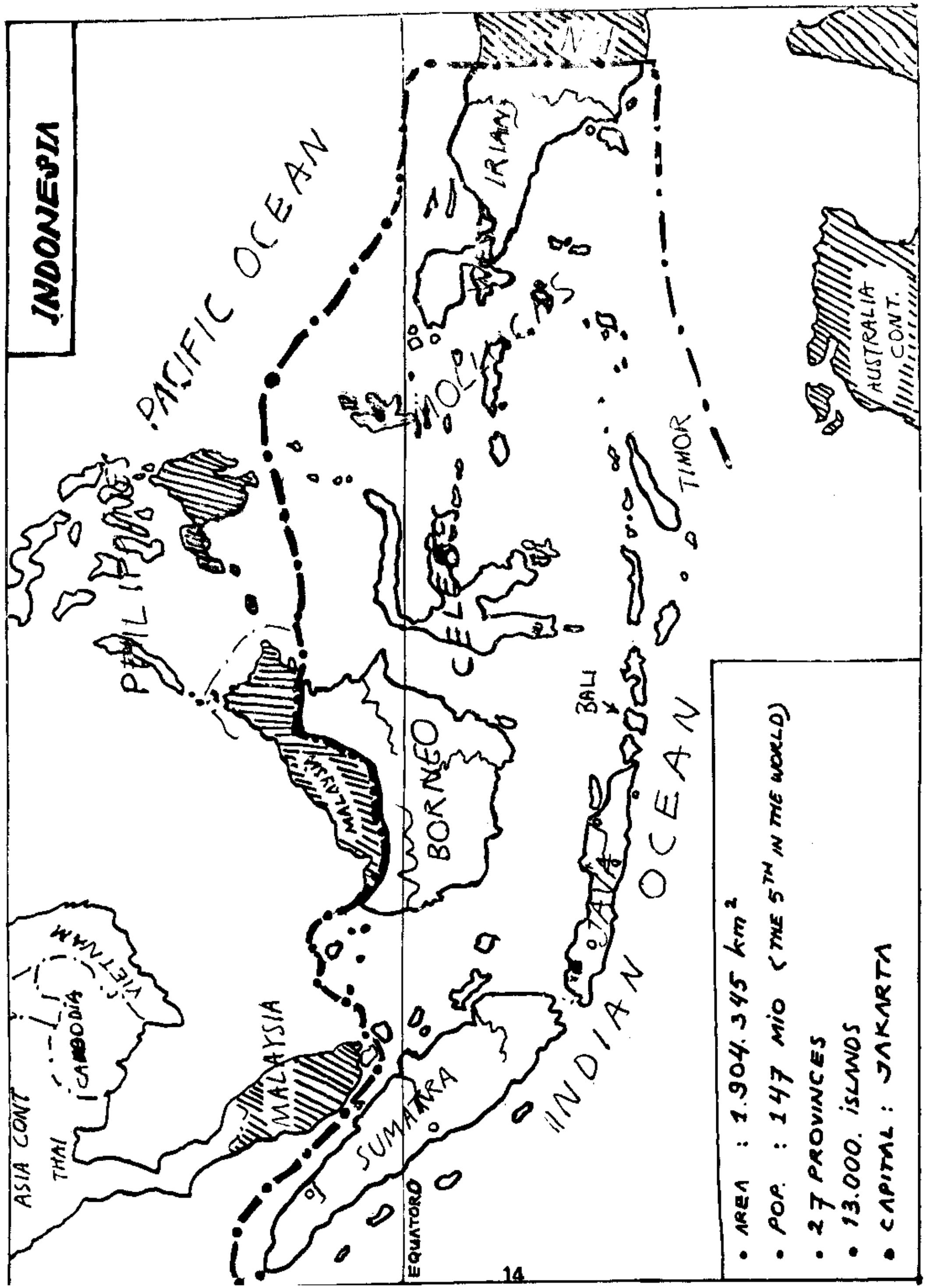


EXPORT COMMODITY (1980):

- OIL : 1.5 MIO BBL/DAY (PROVEN RECOVERABLE RES: 10 Bio BBL
- LNG : 7.5 MIO TONS (" " " 600 m³)

OTHERS:

- TIMBER : 11.78 MIOTONS
- RUBBER : 0.9135 MIOTONS
- COFFEE : 0.239 MIOTONS
- PALM OIL & OTHER VEGETABLE OILS : 0.43 MIO TONS
- TIN : 0.31 MIOTONS
- COPPER : 0.183 MIOTONS
- NICKEL : 0.019 MIOTONS
- TOBACCO ; TEA ; COCOA ; COPRA

OTHER RESOURCES:

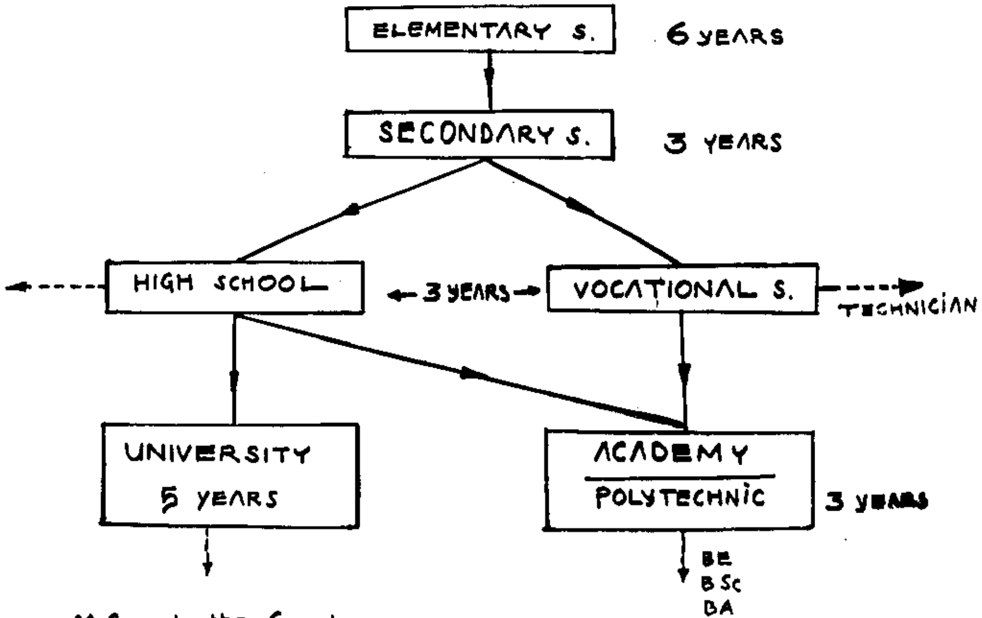
- HYDRO : 31,000 MW
- GEOTHERMAL: 10,500 MW
- COAL : 15 BIO TONS (PRODUCTION 1980 : 400.000 TONS
- GOLD
- LEAD
- MANGANESE
- SILVER
- TITANIUM
- ZINC
- BAUXITE

- RISE IN GDP :
  - 1979/1980 : 4.9 %
  - 1980/1981 : 7.0 %
- RISE IN POPULATION : 2.0 %
- RISE IN INDUSTRIAL SECTOR :
  - Contribution to GDP 1979 : 10.4 %
  - -"- -"- 1980 : 13.4 % (planned 12.6 %)
- ELECTRICITY GEN. INCREASE : 11%-12% (1990), then 7%-8%
- INFLATION 1980 : 16 %
- EXPORTS 1980 : 21.41 Bio $
  - IMPORTS 1980 : 8.60 Bio $
  - ANNUAL SURPLUS 1980: 2.48 Bio $
- PROBLEMS TO TACKLE :
  - 1 NEW JOBS
  - 2 TRANSMIGRATION
  - 3 INDUSTRIALIZATION

AIM AT :

- JOB-INTENSIVE INDUSTRY
- ADDED VALUE
- TRANSFER OF "KNOW-HOW & TECHNOLOGY"

EDUCATION SYSTEM :



- M.S. : in the Country

Ph.D. : abroad

D.Sc. : abroad or local by defending a thesis

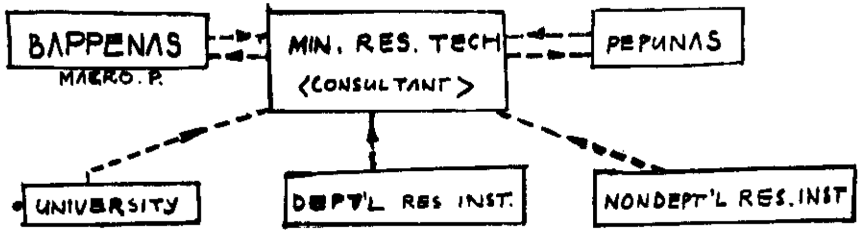
UNIVERSITIES : 40 (states) + 9 (private)

HIGH SCHOOLS : MIN 1 PER REGENCY

SEC. SCHOOLS : MIN 1 PER DISTRICT

EL. SCHOOLS : MIN 1 PER VILLAGE

RESEARCH ORG.



* 8 DEPT. PHYSICS :

1. UI
2. ITB
3. UNPAD
4. UGM
5. ITS
6. USU
7. UNAND
8. UNHAS.

• PRIMARY OBJECTIVES:

- TRAINING
- BASIC RESEARCH
- CONSULTANT (SENIOR SCIENTISTS)

* OBJECTIVES:

- to optimize dept'l operation

e.g.:

• DEPT. MINES & EN.

- INST. OIL & GAS
- INST. MINERAL TECHNOLOGY

• DEPT. FORESTRY & AGR.

- INST. AGR. & FORESTRY PRODUCTS

• LIPI
• BATAN
• BPPT
• BAKOSURTANAL
• B. STAT.
• LAPAN
• PUSPIPTEK

UNIVERSITY:

* RESEARCH ACTIVITIES :

1. GEOPHYSICS
2. ELECTRONICS
3. LASER
4. SOLAR ENERGY
5. SOLID STATE PHYS.
6. REACTOR PHYSICS
7. NUCLEAR PHYSICS
8. ASTROPHYSICS
9. PARTICLE PHYSICS
10. GENERAL RELATIVITY

* MAN POWER :

Ph.D ~ 40
M.S ~ 160

* FACILITY : (Univ. of Indonesia)

- XPS (X-ray Photoelectron Spectrometer)
- XRD (X-ray Diffractometer)
- SOLAR EN. LAB
- THERMAL DILATOMETER
- MCA connected to PDP 11
- MÖSSBAUER SPECTROMETER
- NMR

LIPI

1. LIN (instrumentations)
2. LON (Oceanography & Hydrography)
3. LEN (Electronics)
4. LFN (Physics)
5. LKN (Chemistry)
6. LMN (Metallurgy)
7. LBN (Biology)

BATAN : nat. atomic energy agency.

- has 5 Centers:
  1. PPBMI (YOGYA) : Nucl. mat. & Instr.
  2. PPTN (BANDUNG) : Nucl. technique.
  3. PAIR (JAKARTA) : Appl. Isotop & Rad.
  4. PEPBN (—"—) : Min. & Expl.
  5. PDS (—"—) : DOSIMETRY & Calibration

- Man power : 500 SCIENTISTS
- Facilities : * 2 Research Reactors, MTR being procured.
  - Co^{60} Irradiator
  - * Neut. Generator.
  - * Computer: IBM & 2 small Comp.
  - * Subcritical Assembly.

BPPT

DIRECTORATES:

- D. SARANA
- D. SYST. ANALYSIS
- D. INDUSTRY STUDIES
- NAT. RES. DEV
- D. TECH. DEV :
  - LUK
  - LAGG
  - THERMO & MOTOR
  - TECH. PROCESS
  - EN. LAB. NON OIL. & GAS.
    - * BIOMASS COMBUSTION
    - * BIOMASS FERMEN'N
    - * HYDRO TURBINE
    - * OTEC
    - * NUC. EN. TECH. STUDIES
    - * DIRECT CONVER. SOLAR ENERGY.

    (ELECTRICITY)

UPT:

- NURTANIO (AIRCRAFT)
- PAL (SHIP)
- PROG. ALCOHOL NAT'L. (FUEL)

MANPOWER : 600 ENGINEERS & SCIENTISTS.

PUSPIPTEK - SERPONG/JAKARTA.

B.P.P.T.
1. L. U. K.
2. L. A. G. G.
3. L. T. M. & G.
4. L. S. D. E
5. L. PRO. TECH.

BATAN
6. RESEARCH REACTOR (MTR)

LIPI
7. L. I. N.
8. L. E. N.
9. L. F. N.
10. L. K. N.

ENERGY STUDIES:

M A L A Y S I A

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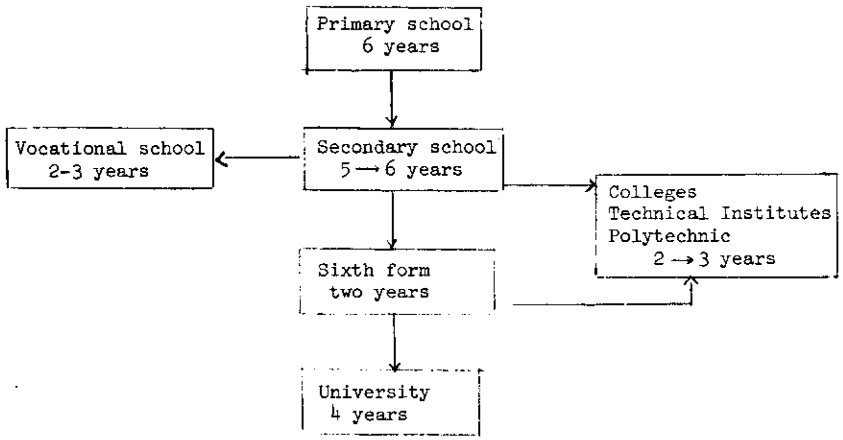
It is very hard to talk convincingly about pure physics and its role in the economic and social development of a country, especially a developing one like Malaysia. On the other hand, the part it plays in helping to establish a good scientific infrastructure that real technological advances so critically depend upon cannot be denied, while on the other, the growing and insistent call for doing the so-called applied research makes the studying of physics seem so pointless. A true physicists is thus always in a dilemma, to keep doing the physics that he likes or succumbed to the pressure and do some kind of applied research. So here I shall only tell you something about Malaysia and share with you my opinion of the role of physics or any other natural sciences has in its development programme. Any number that you come across can best be taken as an estimate.

A little geography and political development of Malaysia seems appropriate here as these will help to bare the unique problems faced by my country as a nation. Malaysia has a political system which may be termed a constitutional periodic monarchy, i.e. we have a king who is elected every five years from among the sultans of the states in the country. It has a land area of 350,000 km^2 spreading over two land masses of pennisular Malaysia and a part of the Borneo (Kalimantan) island. Its population of 14 million consists of roughly 50% Malays, 35% Chinese, 10% Indians and 5% other races. It is clear that the internal political problem of racial unity has been immense, its importance should have been given much more attention than has been hitherto, perhaps even more than that for social and economic development. Malaysia is basically an agricultural country. Main crops are rice, rubber, oil palm, cocoa and pepper. It has also a well developed timber industry. Mineral resources include oil, gas, tin, copper and bauxite. In fact, Malaysia is the largest producer of tin and rubber in the world. The main industries are those associated with the primary commodities just mentioned and those of intermediate manufacturing industries. We import mainly heavy machinery, transport equipment and specialized equipment and chemicals.

Since independence, the government, in order to satisfy the social and economic needs of the people, has embarked on massive programmes of education, agriculture and industrialization based on a realistic estimate on our national capacity. These plans come to be known as the Malaysian Plan and the fourth one is currently being implemented. The main aims of these plans are to eradicate poverty and to improve on the general well-being of the people. Mass education is stressed because it is seen to be a primary and essential tool to eradicate poverty through firstly the noble objective of raising consciousness of the people, and, secondly, and the practical objective of increasing the trainability of the prople.

Prior to independence in 1957, the education system in Malaysia was primarily geared to produced man-power to help in running the administrative machinery of the colonial government, chief clerk was probably the most aspired post then. Little effort was made to devise a comprehensive education system in the country to upgrade the level of consciousness of the people, with the result that illiteracy rate was high then. Since independence the education system has been considerably upgraded by adopting and adapting the best systems available to fit into our Malaysian environment. We now have a fairly comprehensive education system and the following flow chart illustrates the formal system:



Education is not obligatory but more than 90% of the children go to school. Efforts are being made to keep children in schools for at least nine years by not having <u>selective</u> examinations for nine years, however continuous assessment examinations are carried out throughout their school lives for monitoring and corrective purposes. To encourage schooling, no school fee is levied up to the secondary school stage and there are extensive book loan programmes for the poor students.

Normally, students are streamed in secondary four into either science, arts, commerce and vocational streams. Usually the academically better qualified students go into the science stream. To be admitted into the university students have to undergo two years of sixth form or the matriculation programme. Each year about 1/3 of the qualified students or roughly 5,000 students gain admission into the universities.

The first university to be established in Malaysia was the University of Malaysia (UM) in 1962, though it was in existence already for several years. It remained as the only university until 1969 when the University of Science of Malaysia (USM) was established in Penang. Then followed a rapid expansion programme with the establishment of the National University of Malaysia (UKM) in 1970, the University of Agriculture (UPM) in 1971 and the University of Technology (UTM) in 1972. This expansion programme was necessary because of the great demand for university education. It is interesting to note that there is an external degree programme in the University of Science, known as the off-campus programme which caters for working people who are qualified and motivated but unable to attend university full-time. For admission into the universities, a student must satisfy some basic academic criteria. As is the trend everywhere else, students tend to choose medicine, engineering or some professional degree leaving pure sciences and arts as the if everything else fails choice.

Because of the rapid university expansion programme, many problems arise in teaching as well as research. Since most of the universites are barely 10 years old, the main efforts of the universites are directed to consolidate existing facilities and the development of undergraduate programmes to provide the trained personnel needed for the public and private sectors. As a result, development of postgraduate studies and research are relatively slow.

There is at least one physics or physics-related department in each of the five universities. Each department tries not to duplicate the efforts of the other departments, but inevitably there is some overlap. Usually the research interests of any department are spread very wide and thin as staff members are trained in different lines of research, and are unwilling to give up their previous research to participate in another. Nevertheless, efforts are being made to define areas in which to concentrate the manpower so as to achieve a better penetration and efficiency in research.

The following are some of the fields of research that I know of that are carried out in the universities:

Laser physics Plasma physics	the University of Malaya is particularly active in these fields
Solid State physics	this traditional field of physics is carried out in almost all the universities. Studies are concentrated on transport properties of solids
Nuclear physics	practically all the work done is on nuclear theory
High Energy physics	entirely theory, only a few people are involved
Atomic physics	mainly theory, only a few people are involved
Energy research	practically every university has its own energy research programme, mostly efforts are concentrated on solar energy
Geophysics Meteorology	principally on solid earch geophysics, seismology exploration, geophysics and meteorology
Biophysics	mainly carried out in the University of Science. Research programme consists of biomechanics, neutron and gamma dosimetry, environmental radioactivity and so on
X-Ray crystallography	X-ray flourescence and crystal structure determination
Neutron physics	neutron activation studies, these would be carried out mainly in the National University and the University of Science.

In the eyes of the government the main function of the universities is to serve as an instrument for economic and social development. Therefore fields that are "relevant" to national needs or that which promise direct and immediate benfits to development are encouraged, sometimes at the expense of basic research.

Usually there is very little interaction between universities and industry. However in order to emphasize the role of universities in industries, great efforts are being made to create an atmosphere where these interactions are possible. For instance, the University of Science has set up two science-related projects to promote this interaction:

Industrial Consultative Council: the expertise of the university staff, its equipment and facilities are made available to any government agencies or any private industries on request.

TINREG - the Tin Research Group: This group was formed recently because of the realization of our dwindling production of tin and the limited use tin has. The main aim of this group is therefor to facilitate development through research on any problems, present and future, related to the tin industry. The School of Physics is expected to play a significant role in the group because of its unique programme on geophysics.

Other than education programmes in the Malaysian plan, there are massive programmes in agriculture and industry. In order to be more effective in implementing developmental projects in the country, many purpose-oriented organizations, administrative as well as research, were established or expanded. These research organizations, span across a whole spectrum of national endeavours in the fields of agriculture, industralization, medicine and minerals. The number of these kinds of organizations is quite large and so I will just state a few of them. The aims of these research organizations are similar to any purpose-oriented organization, i.e. to facilitate any development through research and study into existing and future problems relating to the purpose:

MARDI - The Malaysian Agriculture Research and Development Institute: This organization is a very large one and it has many sub-research institutes looking into all agriculture research except rubber.

MRRDB - The Malaysian Rubber Research and Development Board: This organization supports two well-known research institutes, viz.

(a) RRI - The Rubber Research Institute

(b) MRPRA: The Malaysian Rubber Producer's Research Association

PORIM - Palm Oil Research Institute of Malaysia.

Other organizations in which research into fields which are of direct relevance to national development are:

Forest Research Institute (FRI)

Meteorology Department (MD)

Institute of Medical Research (IMR)

Standards and Industrial Research Institute of Malaysia (SIRIM)

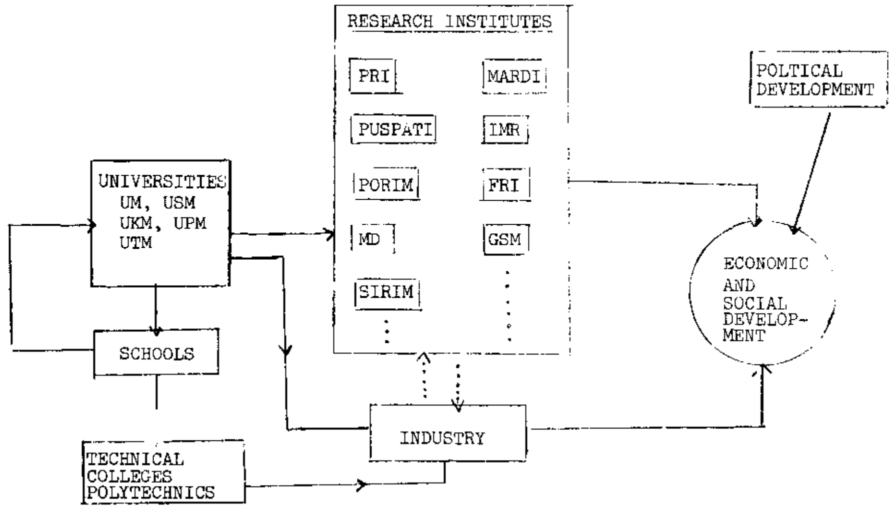
Geological Survey of Malaysia (GSM)

Tun Ismail Atomic Research Centre (PUSPATI)

Others that escape mention.

Invariably some physicists are involved in one way or another in these research organizations.

The direct and indirect role physics or more appropriately any natural sciences plays in the social and economic development of Malaysia can best be summarized by the following flow chart:

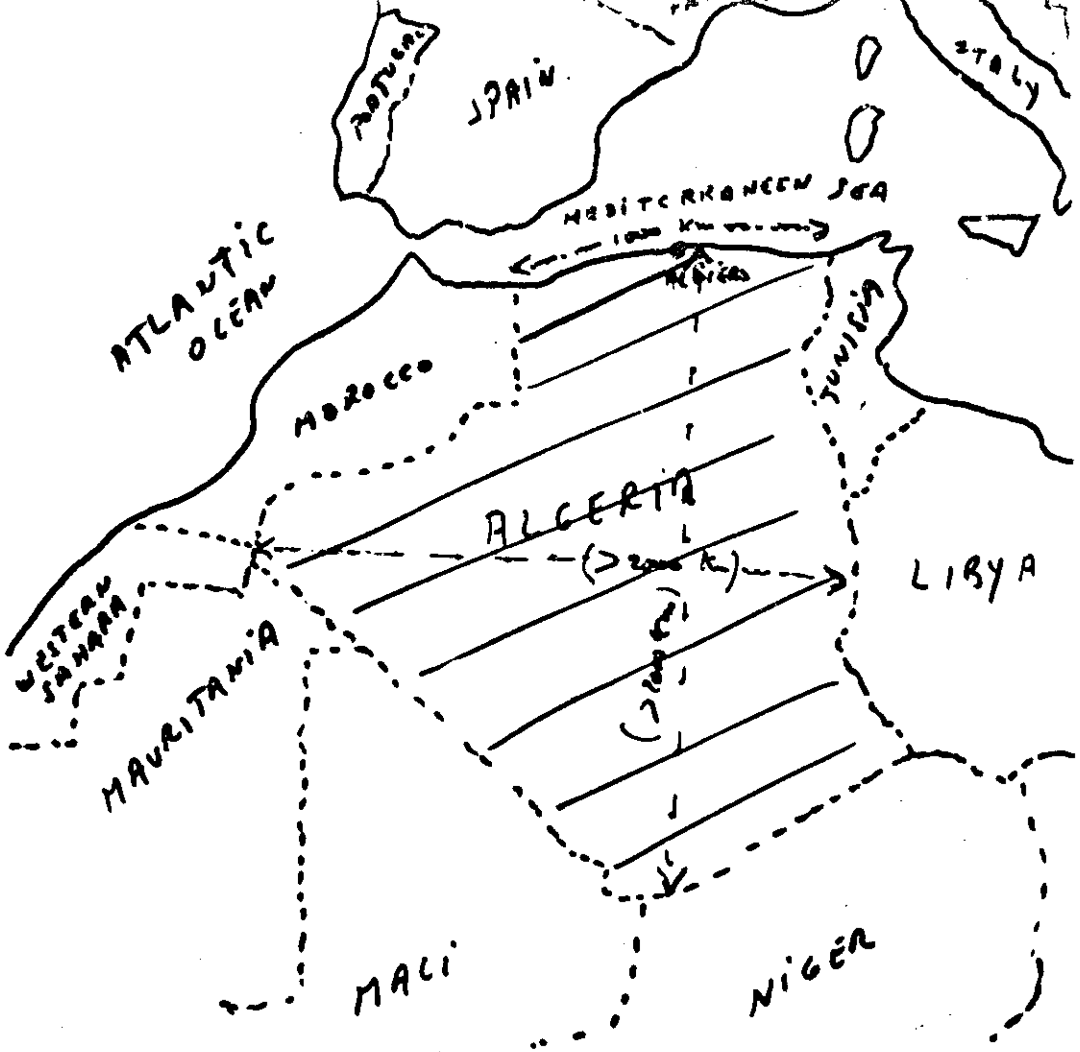


In conclusion I wish to say that if Malaysia is successful so far it is because we have a fairly good development plan based on a realistic appraisal of our national capacity and the creation of an effective implementation machinery. Continued success cannot be sustained elsewhere.

ALGERIA

A. Abzouzi

Centre de Sciences et de la Technologie Nucléaire
Ave. Frans Fanon, Alger-Gare, Algeria.



AREA : 2.380.000 Km²

Population ≃ 18 millions (1980)

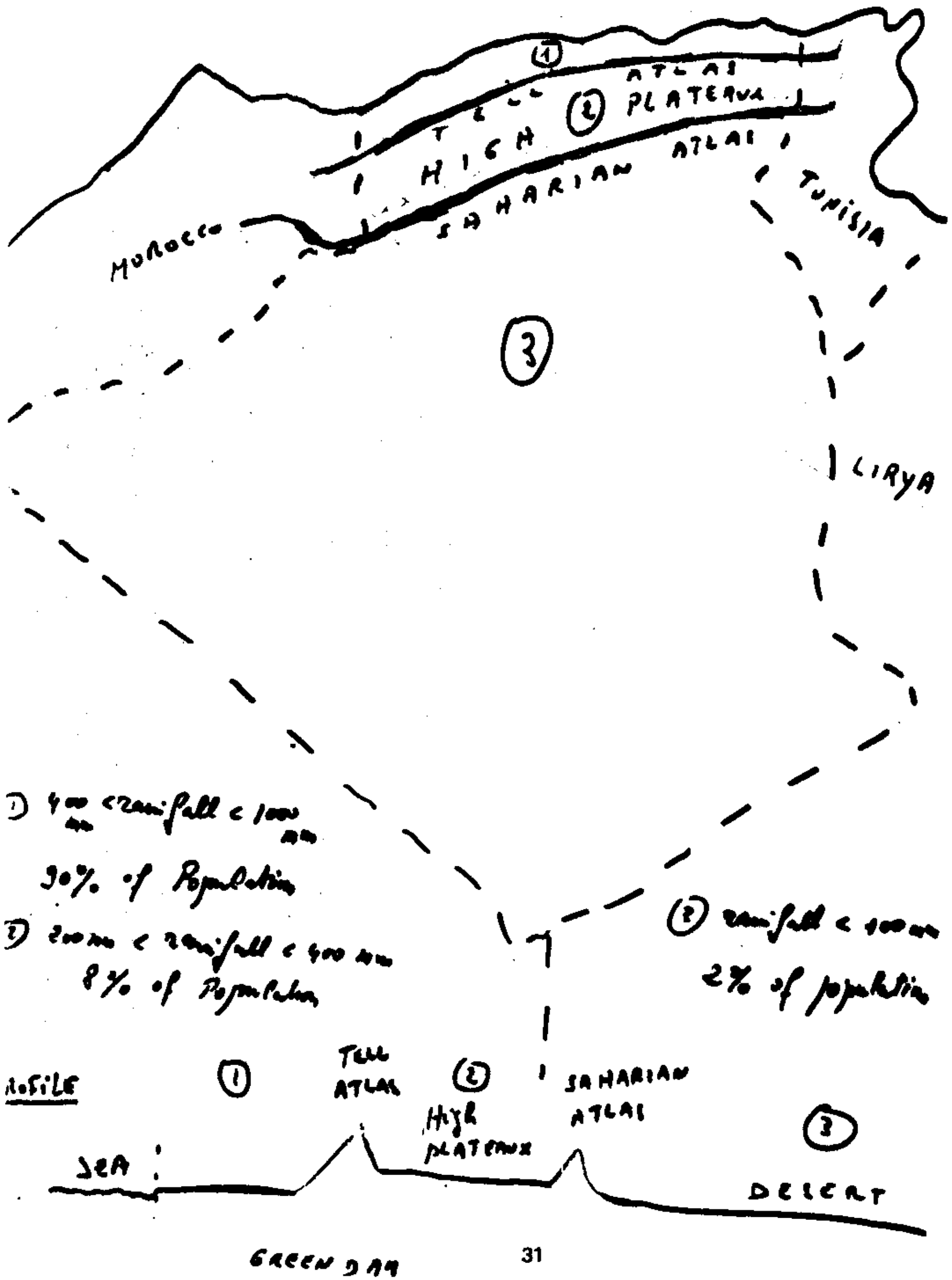
Annual rate of growth = 3.2 %

Birth rate : 44/1000

Official language : Arabic

G.N.P (per capita) = 1590 $ (1979)

PHYSICAL FEATURES



Repartition of Population by age

56% less than 19 years old
38% between 19 and 65
6% more than 65

—

22% economically active population

—

55% of the population live in rural areas
about 100.000 peasants migrate every year to the towns

—

Some comparisons between 1962 and 1970

	1962	1970
Population	10.500.000	18000.000
*** Education**		
- Primary		
Pupils	620.000 (700.000)	3.200.000
Teachers	1500 (24000)	89000
Schools	1800	9200
- Secondary		
Pupils	28000 (42000)	1.040.000
Teachers	120 (2700)	38000
Schools	45	980
- Vocational		
Pupils	1500 (21000)	12500
Teachers	10 (1300)	1020
Schools	46	130
- Teacher training		
Students	250 (3400)	11500
Teachers	10 (230)	980
Schools	6	30
- Higher		
Students	600 (9400)	72000
Teachers	15 (550)	7800
University	1	20

	1962	1970
* Ingeneers	30 (2200)	6500
* Doctors of medicine	120 (5800)	5500
* Public office officials	2000 (55000)	420.000
* Adult literacy	1%	45%
* GNP per capita	190 $	1570 $

AGRICULTURE

ALGERIA is still mainly an agricultural country

	(1000 ha)	
Arable land	6850	(3%)
Under permanent crops	650	(3/1000)
Permanent meadows and pastures	36250	
Forest land	4120	
Other (DESERT)	190.300	
total	238 170	

MAIN CROPS (1979) (unit = 1000 tons)

WHEAT	1200
BARLEY	400
Potatoes	477
Onions (dry)	92
Tomatoes	190
Grapes	190
Citrus fruit	441
olives	140
Dates	208
Watermelons	150

LIVESTOCK (1979) (unit: 1000 head)

SHEEP	10900
GOATS	2600
CATTLE	1300

1970 52% of active pop. 17% of G.D.P
1978 42% " " ↓ 7%

Self sufficiency in Food ↓73% 1969
30% 1980

The third plan (1980 - 1984)
Aim = Achievement of 80% self sufficiency in Food by (main project)

- Large dams (irrigation of 150.000 ha)
- Improvement of production Techniques
- Increase of Mechanisation
- Large use of fertilizers
- Acceleration of "1000 Agricultural villages project" for fixing 85000 farmers

(start 1970
in 1980 140 had been built
207 under construction
156 programmed)

INDUSTRIALISATION

(1) EXTRACTIVES INDUSTRIES (95% of total export earnings)

* MINERALS Controlled by state enterprise SONAREM

	1977 (unit: 1000 tons)
Iron ore (High grade = 60%)	3180
Phosphate rock (10% of World reserves but low content)	721

Also zinc, copper, antimony, lead, mercury, uranium

* PETROLEUM AND Natural gas
Controlled by the state enterprise SONATRACH

. Crude oil (lighter type with low sulphur content)
1979: 52.5 Millions metric tons (4% of total OPEC output)
- 7 Main pipes lines systems
- 3 Refineries (20 million tons/year)

. Natural gas
1977 864 million m³ (4th world producer)
- 4 Main pipes lines
- 4 liquefaction plant (L.N.G: liquefied Nat. gas)
Largest exports of L.N.G

Obs Alignment of gas price with those of oil

2% of active population 33% of the G.D.P

② **Manufacturing**

in 1980 350 state owned manufacturing plants
Controlled by 24 state enterprises

- Iron and steel industries
- Petrochemical complex
- Nitrogenous and phosphate fertilizer plant
- Large farm machinery complex
- Pumps - irrigation equipment
- Tractors - diesel motors
- Vehicle plant (bus, lorries)
- Motorcycles, bicycles, small motors
- paper industry
- Textiles
- Electric goods (radio and television sets)
- flour milling
- Cements works
- Building material

15% of the active population

15% of G.D.P

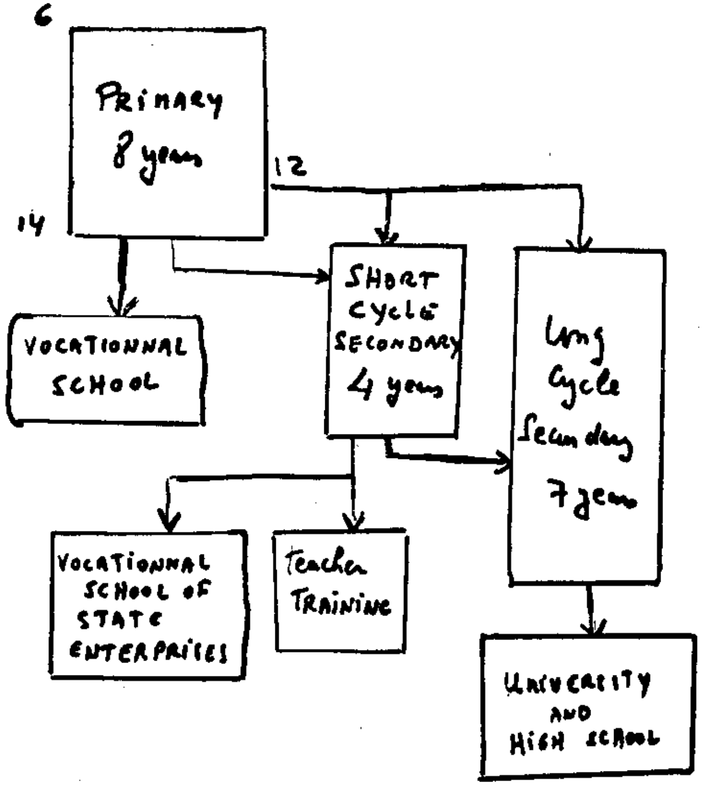
Pb **Low productivity**

Some factories operating only at 30% of design capacity

EDUCATIONNAL SYSTEM

Priority of the country (35% of the administrative BUDG

- obligatory in the primary
- Free at all levels
- 90% of students have a scholarship

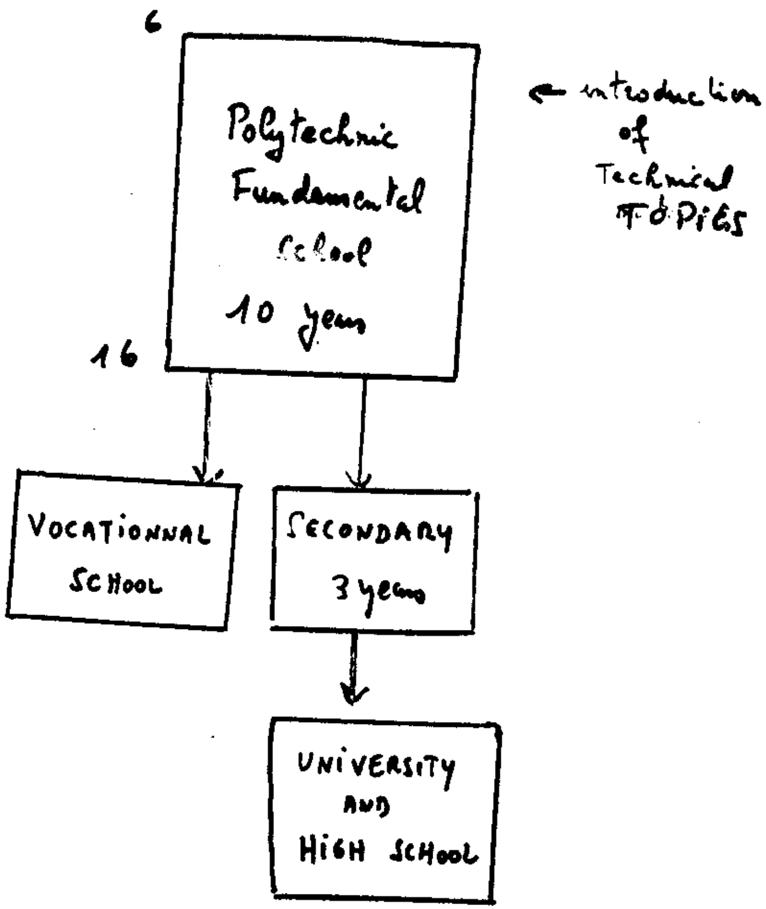


In the primary

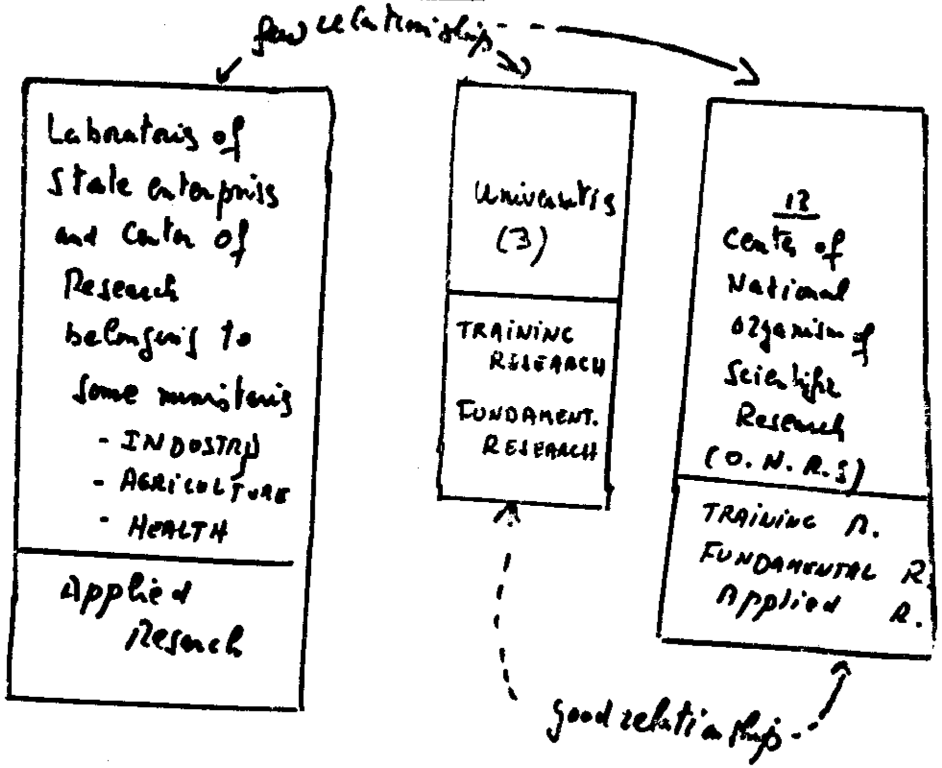
"MID-TIME SYSTEM" Every class room is used 8H per da

For every pupil 4H per day × 6 days = 24 H per wee

Since September 1981



RESEARCH



* MINISTARY OF INDUSTRY

Laboratories of state enterprise

MOST IMPORTANT SONATRACH petrochemistry
SONAREM Geology
SNIC Organic chemistry
. . . . . - — - - -

* MINISTARY OF AGRICULTURE

MOST IMPORTANT

- National Center of Research and Forests experimentation (C.N.R.E.F) (reforesting)
- National Institute of Agronomic Research (I.N.R.A) (selection of seeds)

* MINISTARY OF HEALTH

MOST IMPORTANT

- National institute of Safety and Hygiene (I.N.H.S)

- Pasteur institute (I.P) (microbiology, immunology, preparation of vaccins and serums)

* MINISTARY OF HIGH EDUCATION

- Universities (3)
  - ALGER : Maths, Phys. Chemistry, Biology, geology (300 research workers)
  - ORAN : Maths, Phy. Chemistry, Biology
  - CONSTANTINE : Phys, chemistry, Biology
- Centers of National Organism of Sc. Research (O.N.R.S) (13)

Most important

- Center of Sciences and Nuclear Technology (C.S.T.N) 180
- National center of Arid zones research (C.N.R.Z.A) 60
- Center of study and agronomic research (C.E.R.A.G) 40
- Center of Solar energy (C.E.S) 50
- Center of scientific information and Technological Transfers (C.I.S.T.T) 40

* University of Science and Technology (U.S.T.A)

* Mathematics (3 Post. graduations)
  - Functional Analysis
  - Operational research } 70 researchers
  - Computer science
* Physics (6 post. graduations)
  - Theoretical physics
  - Solid State "
  - Electronics of systems } 105 "
  - Nuclear sciences
  - Solar energy
  - Fluids mechanics

* Center of Sciences and Nuclear Technology C.S.T.N

- Theoretical physics (fission, Nucl structure)
- Solid State (thin films)
- Electronic of system (simulation)
- Experimental Nucl. phys (Nuclear reactions)
- Nuclear engineering

Facilities (Modest)

2 Van de Graaf 3 MeV and 2 MeV
1 neutron generator (will be set up by IAEA in 1982)
2 Mini computers MITRA 15 and MITRA 125
1 Computer CII 10070

Pbs

* No connections between Industry and University
* Scientific isolation for some groups
* Many activities are not connected to the national realities
* In experimental field
  - Very poor maintenance
    lack of engineers
    " " technical personnel
    " " " services
* In Theoretical field
  lack of large memory Computer

- At actual rate of production
  oil will be run out in 20 years
  Natural gas " " " 40 "

PRESIDENT

↓

High Commissariat of New energies (created in January 1982)

the tasks to devellop

- Nuclear energy
  (Nuclear power plant)
- Solar energy.

EGYPT

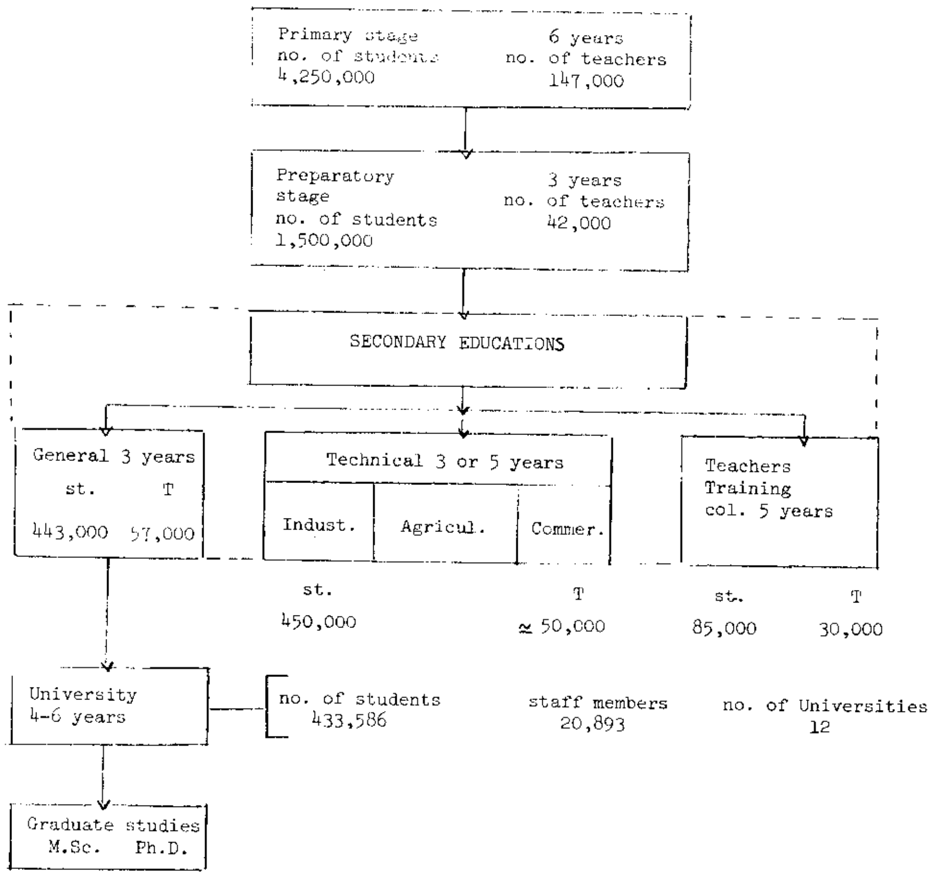
K.M. Naguib

Neutron and Reactor Physics Department, Atomic Energy Establishment,
Nuclear Research Centre, Cairo, Egypt.

Egypt is in the northeast of Africa. It is bounded on the north by the Mediterranean, on the east by the Red Sea, on the south by Sudan and on the west by Libya. The total area of the country is approximately 386 sq.miles, of which, only about 4% is normally habitable, the rest being desert.

For 7,000 years Egypt remained a centre of a flourishing civilization which aroused the admiration of all the peoples of the Mediterranean area and the near East. A long time before the flourishment of Greek civilization, Egypt with its pyramids, temples, sophisticated court life, with the central government and the Pharaoh at its top, really shone. Egypt was also a centre of attraction for the elite scientists and thinkers. Its population now is about 44 millions.

EDUCATION SYSTEM IN EGYPT



RESEARCH INSTITUTES IN EGYPT

The research institutes in Egypt belong to three ministries:

1. Ministry of Education and Scientific Research:
   - a) Universities
   - b) Academy of Scientific Research
     - i) Scientific Councils
     - ii) Scientific Research Institutes (Institute for Marine and Fisheries Sciences, Petroleum Research Institute, Agricultural Research Centre,......)
     - iii) National Research Centre.

2. Ministry of Electricity and Energy
   - a) Atomic Energy Establishment
     - i) Nuclear Research Centre. 12 scientific depts. among them: physics (reactor and neutron physics, experimental nuclear physics, theoretical nuclear physics, plasma physics), chemistry, biology, metalurgy, isotopes, agricultural,....)
     - ii) National Centre for Radiation Technology
     - iii) Regional Centre for Radioisotopes
   - b) Nuclear Power Plants Authority.

3. Ministry of Industry

   Nuclear Material Corporation.

WOMEN AND EDUCATION IN EGYPT

As a woman, it gives me great pleasure to introduce to you a short comment on the role of Egyptian women in the fields of education and scientific research. The Egyptian woman shares with man all his activities.

The following table is a statistical comparison between the number of female and male students in the universities and the percentage of each from 1951-1979:

Academic year	Theoretical faculties			Practical faculties			Total		
	Male	Female	% Fem.	Male	Female	% Fem.	Male	Female	% Fem.
1951/52	17574	1466	8.3	14563	938	6.5	32137	2404	7.5
1970/71	43067	25162	58.5	60892	16602	27.25	103959	41764	40.0
1978/79	172661	95805	55.5	122875	42247	34.4	295534	138052	46.7
rate 51/52 and 78/79	882%	6435%		744%	4404%		820%	5643%	

The number of women working in the field of public services is concentrated most particularly in health and teaching more than any other branch, since these two fields together absorb about 80% of the total number of women employed in the government services.

The following table shows the number of women teachers employed in university teaching jobs in 1978/79

Job	No. of women	Total	% of women
Professor .	245	2214	11%
Assistant Professor	390	2311	16.8%
Instructor	863	3727	23.1%
Assistant Instructor	1203	4962	24.2%
Demonstrator	2361	7679	30.7%

In the field of scientific research the number of women researchers in the National Research Centre is about 36% of the total research workers which is about 1250 and in the Atomic Energy Establishment the number of women is about 24% of the total workers in the organization employing 414 scientists from the two sexes.

It is noticeable that a large number of women employed in this field have made post-graduate studies following their B.Sc. which is indicated in the following statistical table:

Academic degree	Males	Females	Total	% of Females
Bachelor of Science	9	10	19	53%
Master of Science	13	11	24	45%
Doctorate	48	17	65	25%
Total	70	38	108	35%

STEPS TAKEN TOWARDS IMPLEMENTATION OF NUCLEAR POWER PLANTS IN EGYPT

1. Studies began in 1960 to investigate procurement of nuclear power.
2. Based on these studies 19 sites were selected and re-valuated by IAEA experts.
3. In 1963 the AEC together with Kennedy and Dunkon, as a consultant, investigated the technical specifications and siting for the first nuclear power plant.
4. In 1964 a call for a tender including the following specifications were announced:
   a) site at Borg El Arab (near Alexandria)
   b) dual purpose power plant of 150 MWe capacity and 50 $\times 10^9$ m^3 desalinated water
   c) prototype fuel fabrication unit.
5. In 1967 the project was stopped for political and financial reasons.
6. In 1978 a joint committee from AEC and Ministry of Electricity met to restudy the implementation of nuclear power.
7. In 1976 the Nuclear Power Plant Authority (NPPA) was founded to erect, construct and utilize the nuclear power plants for the generation of electric power within the frame of the national development plan.
8. Two agreements with USA and French governments were reached to help in the construction of four nuclear power plans.
9. For siting evaluation several Egyptian authorities together with consultants selected Sedi-Krier (30 km. west of Alexandria) and El Dabaa as two sites for the first nuclear power plants.
10. An agreement with SOFRATOM (France) was reached in 1980 to re-valuate the previously nominated sites and to investigate others.
11. The non-proliferation treaty was signed in Egypt in February 1981.
12. It is planned to construct eight power plants by the end of this century. Their capacity about 6 GWe (out of 25 MWe).

International Cooperation Through Reactor Design and Development – An Invitation.

Farhang Sefidvash
Nuclear Engineering Dept.,UFRGS, Porto Alegre,Brazil.

I, on behalf of myself and all of you, am very grateful to the ICTP through whose initiative and help in cooperation with IAEA, we have been able to gather together here. We from the developing countries are here to receive the latest scientific knowledge and technology in the field of nuclear physics and reactors that the experts from the industrialized nations are supplying us. We are here also to meet each other and learn about each others' research activities with the view of establishing cooperative efforts on an international level.

We as scientists are fortunate to believe the fact that as science does not recognizes the various man made barriers such as political, racial, national, religeous, economical, etc., we also attempt to keep our vision and concepts above these barriers, and try to cooperate with each other in love and harmony in the service of mankind. I would like to see that this gathering gives visible fruit, and an international scientific cooperation comes out of it. All of us, especially those who have liberty to chose their own line of research where we work, can formulate a common project with a common goal, and each one depending his line of interest and possibilities can take up a specific problem to solve. I am sure that if we should get such an activity going, the ICTP and IAEA will offer us best of their possibilities in realization of such a noble international cooperation.

I would like to take this opportunity and invite you to join me in an international activity for developing and designing a new type of nuclear power reactor which is suitable to the needs and possibilities of the developing countries. During this course, we have been introduced to the various types of existing reactors, and we have become aware of <u>some</u> of their many problems.

These are the reactor concepts whose developments began a few decades ago, based on the information and experiences which were available at that time. During the course of development and operation when they confronted with various problems and safety requirements, they found that they had already put too much money in the efforts and too late to change the basic concepts. Therefore, they have attempted to make modifications and device new systems to relieve some of the problems. This is why we have such complicated and expensive reactors.

Don't you think that today, based on the existing nuclear science and technology and reactor experiences that have been accumulated over decades, we can come up with a new reactor concept which can combine the advantages of the existing nuclear reactors while avoiding their problems? Why not? I think that we can have a proposal for such a reactor concept. I have been involved in it's study and development for some years, and the project has been supported by various research contracts. The reactor is Organic Cooled, Thorium Fueled, Fluidized Bed Nuclear Power Reactor. A general description of it appear in the following pages which is part of a published paper. Since then, there have many changes and improvements come about as a result of calculations and experimentations. It is simple in design with inherent safety features and suitable to the needs and within the capabilities of the developing countries to develop, design and finally construct such reactors. To add to the list of advantages of this reactor over others, which appears in the article, it inherently eliminates the consequences of the Loss of Coolant Accident. The reactor is constructed from many basic modules; therefore, any size reactor can be made by putting together various numbers of the basic module. The reactor has a good load following property. Nowadays when the economics and safety of nuclear power reactor are important issues, I think that such a reactor has a great future.

By no means the conceptual design of this reactor is complete. It is just the beginning. This is an invitation for you to join in and offer your ideas and make changes that make it a better reactor. The best nuclear scientists and nuclear engineers from the developing countries are gathered together here, and of course exist others who could not come and stayed at home. Let us demonstrate our capacities and capabilities in forming a nucleus for an internationl Scientific activity.

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A NUCLEAR POWER REACTOR CONCEPT FOR BRAZIL. By and Other Developing Countries.

Farhang Sefidvash*

For the purpose of developing an independent national nuclear technology and effective manner of transferring such a technology, as well as developing a modern reactor, a new nuclear power reactor concept is proposed which is considered as a suitable and viable project for Brazil to support its development and finally construct its prototype as an indigeneous venture.

INTRODUCTION. The economic wealth of a nation is the result of three factors namely natural resources, manpower, and technological knowledge. In order to effectively utilize the natural resources and manpower to the best interest of the country, the development of technology is essential.

In today's world, a nation such as Brazil cannot simply be the buyer of the nuclear power plants to supply its increasing energy demands and stay dependent on other nation's nuclear technology. Historically viewing, the manners by which a country has been exploited by other nations have been in the forms of military, economic, political, and technological dependencies. It is widely agreed that the technological exploitation is the most harmful and destructive to the dependent nation. For this reason, the realization of the transfer of nuclear technology is considered as an important and integral part of the Brazilian nuclear program.

In this paper, a new nuclear power reactor concept is discussed which its development can gain us safe and simple reactors for the supply of the future energy demands. This will also provide practical means for transfer of technology.

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TRANSFER OF TECHNOLOGY. In today's world, where individual nations consider their own interest above the interests of all others, and a world which is often described as spiritually destitude, morally bankrupt, politically disrupted, socially convulsed, and economically paralyzed, one cannot expect to accomplish a transfer of nuclear technology in its true sense of meaning and purpose. The nuclear technology is such a complicated technology that should the good will of the doner be wanting, the receiving partner may even have difficulties in defining the details of necessary and needed technological knowledge. Therefore, it is immensely dificult to accomplish the true transfer of technology under the world's present conditions.

The ideal of transfer to technology, as expected and desired, can only be truly realized in the world of the future when the basic concept of Unity of Mankind is accepted and practised by all. That world unity is the goal towards which a harassed humanity is striving and as, for example, expressed in the Baha'i vision, implies "the establishment of a world commonwealth in which all nations, races, creeds, and classes are closely and permanently united. (...) This commonwealth must consist of a world legislature, a world executive backed by an international force, and a world judicial. (...) The enormous energy dissipated and wasted on war, whether economic or political, will be consecrated to such ends as will extend the range of human inventions and technical development, to the increase of the productivity of mankind, to the extension of scientific research, to the sharpening and refinement of the human brain, to the exploitation of the unused and unsuspected resources of the planet, and to the furtherance of any other agency that can stimulate the intellectual, the moral, and spiritual life of the entire human race" (1).

Therefore, until such a time comes, the need in today's world remains for the development of an independent national technology possibly only assisted by other nations. We cannot expect, in this competitive world, to receive the technology on a good will basis and hope that everything needed will be given to us. Even though it is given, we can have difficulty in understanding it. Theory is that science may be transfered and acquired through literature and instructions, but technology is not transferable in that manner. Technology is only aquired through actual involvement in research, development, and finally construction of the systems and components. Therefore, the scientists and engineers in the country need to involve themselves in actual projects in order to gain technological know-how.

A careful analysis of presently existing nuclear power reactor concepts, in the light of the knowledge accumulated over two decades, can lead us to a better concept incorporating the best features of existing nuclear power reactors while trying to avoid the faults. This will result in a concept suitable to the needs and conditions of the country and worthy of development while the technology related to various components can be developed nationally or partially acquired from other nations on a more competitive basis.

THE PROPOSED CONCEPT. The conceptual design of the proposed nuclear power reactor utilizes the fluidized bed concept. The concept attempts to utilize the best known features of different reactor types. A cylindrical stainless steel calandria contains the moderator and reflector. The spherical fuel elements or the fuel pellets floating in the light water or organic coolant are contained in the vertical calandria tubes made of zircaloy. The coolant flows upward through a bed of solid fuel pellets which then become borne or fluidized but not transported. The velocity of the coolant can be maintained over a wide range. The lower limit is that necessary to just bouy the solids. The upper limit is that which would just transport or carry the solids out of the bed.

FLUIDIZED BED NUCLEAR REACTOR CONCEPT

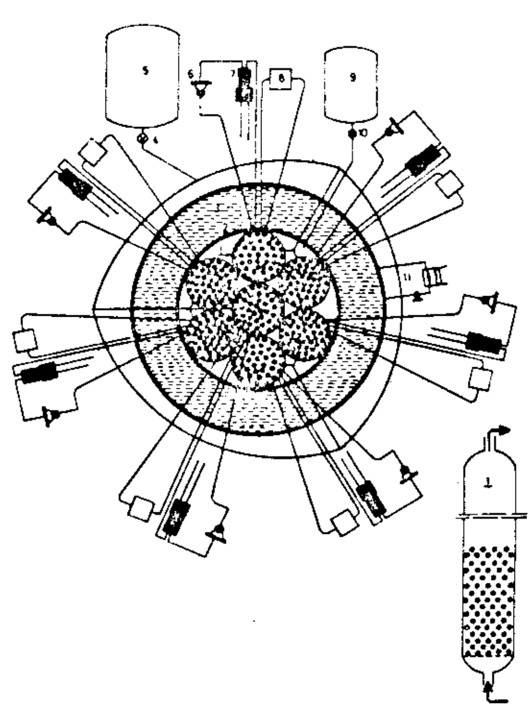

Figure 1 – Fluidized bed nuclear reactor concept: (1) calandria tubes, (2) calandria, (3) reflector, (4) emergency core cooling system valves, (5) accumulators, (6) coolant pumps, (7) steam generators, (8) automatic refueling machine, (9) borated water tank, (10) emergency reactor shutdown valve, and (11) reflector cooling

The bed is in a state of turbulence, and the fuel pellets are in constant motion, resulting in good mixing and high heat transfer rates. In the collapsed condition, when the fuel pellets are in the packed, unfluidized state, the physics of the core is such that the ratio of the fuel to the moderator is not critical. The reactivity control could be accomplished by the change of buckling through the control of coolant flow velocity and also by changing the level of moderator in calandria. An emergency safety system would consist of a number of tupes in the reactor core in which borated water could be rushed in. A system for clean-up of the fission product release is envisaged. In the case of loss of coolant accident (LOCA), the emergency core cooling system (ECCS) for the removal of decay heat would spray borated water from the top of the calandria tubes supplied from the accumulators.

The intimate mixing and agitation result in a uniform temperature distribution throughout the bed, thus reducing hot spot factor. For the same reasons, a uniform burn-up of all the fuel pellets irrespective of the shape of the neutron flux distribution will be obtained. Each calandria tube has a perforated-plate bottom and a flared top. This plate is designed to evenly distribute the flow into the fuel bed so that proper fluidization can be obtained. The top of the tube is flared to reduce the velocity of flow there and to ensure against the escape of any fuel elements that may reach that height. However, as an added safety feature, an adjustable top screen is provided which definitely limits the expansion of the core.

The height of the active core resulting from the heights of the top-most fuel pellets in each tube above the perforated plates varies with coolant rate of flow. Therefore, the control of the reactor may be achieved without control rods and only by varying the coolant flow rate within the wide range of fluidization. An increase in flow increases the height of the active core and therefore the distance between the fuel pellets, and thus the moderator fuel ratio is increased. The reactor could be designed to have a large negative temperature coefficient of reactivity, thus providing stability and safety against power surges. The fuel elements for the reactor are simple spherical pellets made of natural or low enriched uranium metal or uranium dioxide that may be claded by coating with zircaloy or stainless steel. Thorium could be mixed with the fuel for the purpose of having a thermal breeder reactor.

Light water or organic compounds may be used as coolants. Among organic compounds, the polyphenyls are the most resistant to the decomposing effects of high temperatures and nuclear radiations present in the reactor core. They have good heat transfer properties combined with low vapor pressures, thus requiring thin calandria tubes. One of such choices could be a Monsanto product called HB-40 which is a hydrogenated terphenyl in the form of liquid similar to lubricating oil.

Refueling is performed continuously and while the reactor is in power. Fuel is introduced into, or extracted from, the core while it is in a fluidized condition by the use of a tube that enters the core top. To add fuel to the core, slurried fuel is simply pumped through this tube and into the core. To remove fuel, the flow direction is reversed, the tube is lowered into the fluidized core and the slurriel fuel flows out of the core. The particular activity of the spent fuel is then measured and thus the burn-up of fuel pellet is determined. If the fuel's burn up is below the expected value, the fuel is returned into the reactor, but when the fuel has suffered sufficient burn up it is ejected into the decay heat removal system. The continuous process of refueling allows the reactor to operate with minimum excess reactivity, thus making the use of burnable poison unnecessary.

In designing a nuclear power plant powered with this reactor, the present trends in reactor safety towards the redundancy and diversity in direct and indirect safety related systems will be considered. Redundancy and diversity are applied in tripping, cooling and containing the reactor. Safety related auxiliary systems will be made of two identical and segregated trains and the active components in each train (pumps and motor operated valves) will in turn be duplicated in each train. The diversification of the systems should cope with the problem of "common mode failures" which lead to complete loss of identical equipments. All credible accidents including the most severe such as (1) loss of coolant accident, (2) steam line break, (3) sudden rupture of steam generator tubes, and (4) complete loss of power supply, would be analyzed by the well-known fault tree and probabilistic approach. To each branch of the fault or event trees, a probability of radioactive release to the site will be assessed and the risk to the surrounding population would be computed taking the site geographic and weather conditions into account.

Some of the advantages of the proposed concept may be summarized as follows: (1) less sophisticated design resulting in more reliable reactor which would be possible to be built even by a country with modest industrial infrastructure; (2) since each calandria tube or a batch of tubes may be made to feed an independent loop containing modest amount of energy, the probable loss of coolant accident is necessarily a small one and can be counteracted by a simple emergency core cooling system; (3) possible use of natural uranium as fuel thus becoming independent of the monopolized enrichment services available; (4) good heat transfer conditions; (5) simple and safe control systems; (6) continuous refueling system resulting in higher reactor availability; (7) need for lower reserved reactivity and therefore no need for burnable poison; (8) simple refueling machine; (9) simpler fuel fabrication method since there are no fuel assemblies to construct and all of the pellets are of the same enrichment; (10) uniform fuel burn up of the pellets is obtained; (11) there is no problem of seismic effect on the fuel; and (12) due to the low fuel inventory and the possibility of using thorium cycle, the problem of nuclear proliferation is minimized.

REACTOR PHYSICS CALCULATIONS. The feasibility of this concept has been investigated by preliminary reactor physics steady state calculations.

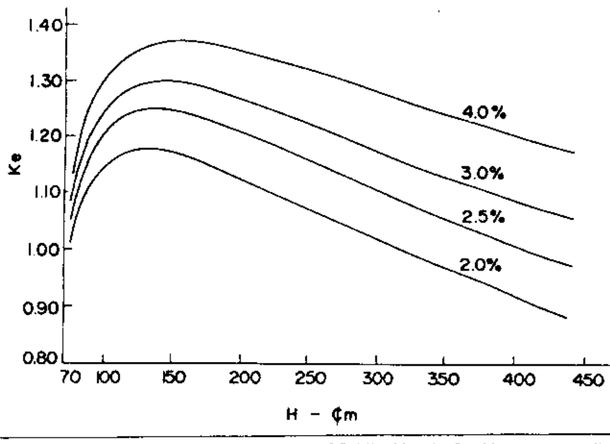

Figure 6 – Variation of k-effective as a function of fluidized height for 66. cm reactor diameter with collapsed height of 75. cm for different enrichments and zero thickness of calandria tube

REFERENCES:

1. Sefidvash,F. "Preliminary Thermal Design Calculations of the Fluidized Bed Nuclear Power Reactor" Atomkernenergie 1982 (In Press)
2. Sefidvash,F., M.R. Haroon; "Preliminary Reactor Physics Calculations of a Fluidized Bed Nuclear Reactor Concept" Atomkernenrgie <u>35</u> (1980) 191-195
3. Sefidvash, F. "A Nuclear Power Reactor Concept for Brazil" Rev. Bras. de Tech. <u>11</u> (1980) 145-158

C O L O M B I A

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The project of an International Centre of Physics in Colombia

About three years ago a proposal for the establishment of an international center of physics in Colombia began to be considered. It has enjoyed increasing favor since then(1). At the present it has reached such an advanced level of elaboration that in a few weeks the first activities of the center will begin. Here we shall briefly present the motivation for the proposal, its status and the 1982 program of activities

First of all, let us recall that last September there has been a meeting here at ICTP, where some twenty proposals of international centers were presented(2). The meeting place was testimony to the role ICTP and Trieste have played in the promotion of science in the developing world. Moreover, the meeting itself indicates very clearly the increasing concern for scientific and technological development in the Third World which drew world-wide attention in the important Vienna conference of 1979 which led to the creation of the Interim Fund. The meeting also indicates that the creation of research centers is considered especially appropriate for this goal(3).

Our center was one of the first to be proposed, although its general goal, scientific and technological development, is no different than that of the others. Its activities will be focused on the Central American, Caribbean and Andean region. The reasons

for this limitation are the existence of excellent centers in other Latin American countries and a certain homogeneity of problems within the region. Of course, this will not exclude cooperation with other centers, and some examples of this are already under study. In fact, in the other centers that are proposed (Brazil, Mexico, Peru and Venezuela) there is some overlap, and it is highly desirable that there be coordination within the overlap so that the network of these centers becomes an effective agent for the scientific development of all of Latin America; an analogous cooperation is expected to take place with countries from other regions of the world. In practice, our regional specification refers mostly to our fellowship policy.

An obvious question could be: Why a physics center in Colombia? It is, of course, equally obvious that such a question could be asked for whatever center is proposed. Nevertheless, there are a number of points which may clarify the sense of our choice.

One is the importance of physics in general and its experimental side in particular. In this connection we wish to recall how Leite Lopes, for instance, has often stressed the importance of this point <u>also</u> in developing countries. Certainly there are prejudices to fight. Often it is considered to be a luxury that a developing country does research in physics partly due to the extrapolation of the high costs of certain fields of physics to all the rest. Some fields are less expensive than others and developing countries have sound reasons for selecting these over others, of course, but this in itself does not exclude expensive fields where international cooperation may make them accessible(4). In this connection, we recall that at a recent meeting in Cocoyoc and last January in Bogotá Lederman stressed the fundamental cultural importance of a field like high-energy physics. He said that it has to be included in the development plans of the Third World, even though its high costs may give it some other priority than that received in the developed countries. In this respect, it should be noted that for post-war Europe, it certainly was a sound policy to promote CERN and that this great economical commitment has certainly proven to be a fantastic investment from both the scientific and technological point of view. Therefore, we think that an analogous investment, obviously on a much smaller scale, must now be made in developing countries.

A second point is the fact that in the last two decades Colombia has developed its manpower in physics and has seen an increase in research[5]. Certainly this is important if one wants to undertake the establishment of a center in a country[3].

Concerning our project, we foresee a number of benefits for the region in general and Colombia in particular if the center is established. It will be a place for training experimental physicists, for supporting regional activities directed towards improving research and educational efforts, for providing on-service training of the professors of the less developed universities of the region, and for developing experimental and theoretical research. We do not believe that it should have academic duties by itself, although it may cooperate with the universities' programs. By this we mean we do not expect to offer degree programs like the Ph.D., although this does not exclude offering opportunities for doing research which might lead to such a degree given by a university, for example.

An application of these ideas may be seen in the program of 1982 activities given in the Table. The criteria used to determine course subjects have been the perspectives for future experimental

activity and the social and technological relevance. Incidentally, these make it easier to obtain financing for the activities. Nevertheless, in the future we will be including some pure physics. At present we are working on the definition of the program for 1983 which is expected to be ready in about one month.

There are other benefits which also should be mentioned. The center will provide a first-class infrastructure in the region as well as the possibility of fostering contacts between scientists. The importance of the latter requires no special comment in a place like Trieste, with an audience like this.

Our project has already received good support in Colombia. Colciencias, the Colombian National Research Council, and its Director, Dr. Efraín Otero, have supported us with great enthusiams in our first steps, contributing in a substantial way to our activities. Other Colombian government institutions like ICFES (the Colombian Institute for the Promotion of Higher Education), and IAN (the Nuclear Affairs Institute) have also supported the idea. The physics community, in the last meeting of the Colombian Physical Society (August 1981), voted to adopt a resolution in favor of the project. Moreover, all the major national universities are cooperating in our activities and two of them, the Universidad Nacional and the Universidad Pedagogíca Nacional, have offered land for the center's site, besides, we have also received an analogous offer from the Mayor of one of the most important Colombian towns.

At the international level we received valuable advice and support during the already mentioned last year's meeting. A result of this meeting a year ago was the creation of the ACIF, the non-profit organization which serves as the legel backbone of the center and is promoting its creation as well as organizing the activities which eventually will correspond to it.

We must insist on the international nature of our project. Besides the international character of our activities, we should mention the following: The physical societies of the region will be accepted as members of ACIF upon application and they will have special rights of representation on the Board of Directors. Moreover, we have just formed the International Scientific Council, with Lederman and Salam as co-chairmen, and this is composed of twelve scientists, none of whom is Colombian.

The fact that Lederman and Salam have been invited to head the scientific council is, of course, not only for their personal scientific prestige but also reflects our appreciation for the role their institutions play in developing science in the Third World. We already commented on Trieste. Here we want to express our interest for a project currently being studied at Fermilab, concerning the institution of a Latin-American Institute there. We think that our center must support this project and cooperate with it in the form which is considered to be most appropriate.

REFERENCES

1) Report on the International Physics Symposium, Bogotá, 12-17 January 1981, Colciencias.

2) Proceedings of the meeting on Science Transfer and International Research Centers, Trieste, September 1981, in preparation.

3) M. Moravcsik, "How to establish a research center in a developing country", Karachi; November, 1981.

4) M. Cini and G. Violini, Naturaleza, to be published.

5) H. Rodríguez, in ref. 1, p. 6.

PERU

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Ladies and gentlemen:

You must be very kind with me, because my English is a little poor, but I must fulfil my compromise of give to you some glimpses, some picture, of the cultural and scientific development of my country: Peru.

But where is and what is Perú?

Here it is: sorrounded by Ecuador, Colombia, Brasil, Bolivia,

Chile and the Pacific Ocean.

Peru, is one of the developing countries of Latin America.
Trying to talk about the cultural development let me re-member, first of all, that: many of the countries that we call underdeveloped, many centuries ago, they were, at their proper time, the developed countries.
So happen in America, where some of the ancient high cultures were born, like the Aztecas and Mayas in Mexico and Central America and the Incas in Peru and along South America, with some astonishing characte-ristic in Science and Technology, like by example for the Incas: They have give us the potatoes, the cotton, the corn, ----

- They worked, their textils, almost with all the techni-ques known till today in the wold and did the finest of them (according to the specialists in textils), only superated with the new sinthetic fibers.
- They constructed and maintained the longest road for their time, with special stores for food, clothes and others... each half a journey.
- They constructed stone channels for agriculture and used some techniques that actually some experts are trying to repeat for fighting the desertification of the earth.

The conquest of America by the spanish was the rupture and destruction of this development.
The independence of Spain, after three centuries, was not been able, till now, for replacing such an homogeneous cul-ture.
Peru is now a country with an extension of 1'200,000 Km.^{2} and a population of 18'000,000 inhabitants.

Some useful data

Energy Proved Resources:

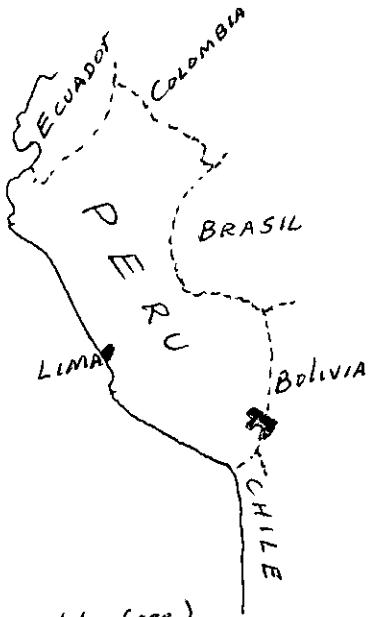
Oil: 850×10^6 barrels
Coal: 7×10^6 tons.
Hydro: 56,000 Mw

Instaled Power: 1982

Thermal (Oil): 1700 Mw
Hydro : 1500 Mw

Principal Resources

Fishiery (in 1967: 1st in the world)
Mining: Cooper
Silver
Gold
Indium
Molibdenum
- - - -



Education System

Primary: 6 years (Obligatory and by free)
Secondary: 5 " (Not obligatory but by free)
University: 5 to 9 years for Professional degree (Selective by free)
+ 2 years for Master Degree

Universities: 33 Universities

	Staff
UNI	~ 40 Master or PhD
SM	15 " " "
UC	16 " " "

Physic Degrees only in 5 of them
Math. " " " 4 " "
Engin. " " " 9 " "

In the field of Science and Technology, we are just beginning to scratch on the surface of the [redacted] actual scientific and Technological Knowledge.
We have very few Physicists and Mathematicians, almost all of them working in the Universities
We have more Engineers, working in Industry, Universities and other fields. We have 18 classes of Engineers; some examples of their quantities are:

Civil Engineers	-	[illegible]600
Mechanical	"	3000
Electrical	"	2500
Chemical	"	2500
Industrial	"	1400
Geological	"	1400

<u>Physic</u> <u>and</u> <u>Nuclear</u> <u>Energy</u>

The re[illegible] on Physic is worked with emphasis in the Universities. By example in the Nat. Engineering University: UNI The technological application of Nuclear Energy are being implemented in the Peruvian Institute of Nuclear Energy (IPEN).
In the UNI, there is a group of Physicists who work on:

- Magnetic Resonance
- Thermoluminiscence
- Mössbauer Spectroscopy
- Solar Energy (Selective surfaces, ...)
- Laser construction (CO_2)
- Others

The Peruvian Institite of Nuclear Energy works according to the Nuclear Plan of Peru (1976). The objectives in the 1st Stage (1977-1983) are:

- Formation of a Basic Scientific and Technology [illegible] ture in the nuclear field (Man power)
- Implement the Basic Operational [illegible]
- To stablish the Uranium Resources [illegible]
- To define the convenience [illegible] the nuclear [illegible] tricity in our national grid

In the 2nd Stage (1983-2000), [illegible]

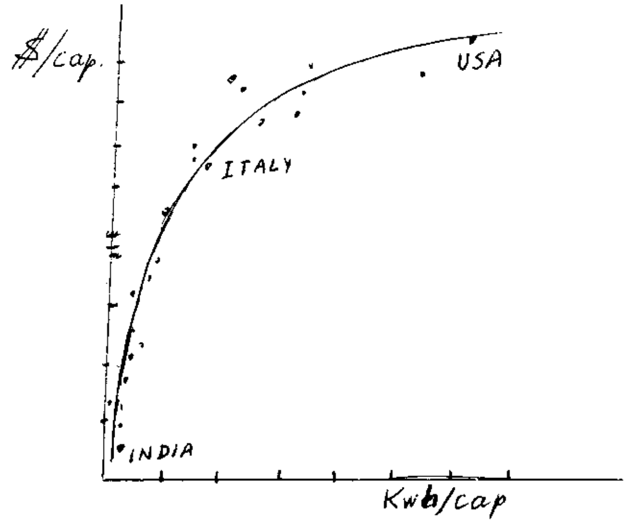
- The efective transference of the [illegible] nuclear energy that could be useful [illegible] our people in medecin, agriculture, industry, ...

We have, also, the Geophysic Institute for the study [illegible] of the Physic fenomena of [illegible] tosphere and the Nat. Agriculture University [illegible] in the applications of radioisotopes [illegible]
The implementation of the [illegible] on with an agreement with A[illegible] Commission, who is in charge [illegible] the Peruvian Nuclear Research Centre [illegible] Swiming Pool Type Reactor
Finally, I like to observe that the little [illegible] velopment of my country offers actually [illegible] tunities to the physicists, specially to the [illegible] physicists, which are pressed to [illegible] the technological applications (radioisotopes applications, energy [illegible] cal applications [illegible] duction, metallurgy, metrology, quality control, agricultural research, ...) where they must push the technological methods at a superior level compared with the actually used.

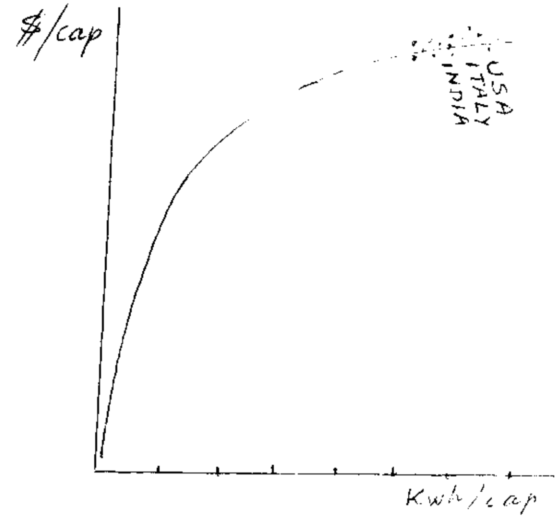
But we are not pesimistic and we hope that, in the measure that we will be able to industrialize our raw materials, giving, step by step, more and more agregate values to them, the science and technology will find a more and more appropriate enviroment.

We must create also an appropriate technology and a human capacity which could absorb the new technologies according to our needs which must be in accordance with the needs of humanity like a unit.

All people in all the world, was able, sometime for doing marvelous things. All people is able for doing nice and beautiful things, once again. The secret remains, I believe, in the way in which we will use, in the future, the energy and the human power trying that the Aoki's diagram, that looks like this, actually:



became like this:



That is to say: when all the people in all the countries of the world, uses, in average, the same quantity of energie.

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WINTER COLLEGE ON NUCLEAR PHYSICS AND REACTORS

(25 January - 19 March 1982)

including

Part I: Course on Advances in Nuclear Theory and Nuclear Data for Reactor Applications (25 January - 19 February)

Part II: Course on Reactor Physics Aspects of Safety Analysis February - 19 March)

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34.	S. GUNGOR C.N.A.E.M. P.k. 1 Istanbul Turkey	x		Turkey
35.	M.R. HAROON Centre for Nuclear Studies Pakistan Institute of Nuclear Science & Technology P.O. Nilore, Rawalpindi Pakistan	x	x	Pakistan
36.	S. HLAVAC Institute for Physics Slovak Academy of Sciences 899 30 Bratislava Czechoslovakia	x		Czechoslovakia
37.	A.Z. HUSSEIN Reactor and Neutron Physics Department Nuclear Research Centre Atomic Energy P.O. Box Cairo Egypt	x	x	Egypt
38.	H.M. HUSSEIN Department of Engineering Physics & Mathematics Faculty of Engineering University of Cairo Giza, Egypt	x	x	Egypt
39.	M. ISRAR Reactor Operation & Maintenance Group Pakistan Institute of Nuclear Science and Technology P.O. Nilore, Rawalpindi Pakistan	x	x	Pakistan
40.	J.D. JORDANOV Institute of Nuclear Research & Nuclear Theory Boul Lenin 72, Sofia Bulgaria	x	x	Bulgaria
41.	U. JUJURATISBELA National Atomic Energy Agency Research Centre for Nuclear Techn. Jalan Tamansari No. 71 Bandung, Indonesia	x	x	Indonesia

	Name and Institute	Attended Part I	Attended Part II	Member State
42.	M.C. KALRA Department of Nuclear Engineering & Technology I.I.T., Kanpur 208016 India		x	India
43.	A. KERESZTURI Central Research Institute for Physics P.O. Box 49 H-1525 Budapest Hungary		x	Hungary
44.	A.M. KHAN Department of Physics University of Dacca Dacca-2 Bangladesh	x		Bangladesh
45.	V. KNAPP Department of Physics Faculty of Electrical Engineering P.O. Box 170 41001 Zagreb Yugoslavia		x	Yugoslavia
46.	N.T. KOIUMJIEVA Institute of Nuclear Research & Nuclear Theory Boul Lenin 72 Sofia Bulgaria	x	x	Bulgaria
47.	W.-K. KOO School of Physics University of Science of Malaysia Penang Malaysia	x	x	Malaysia
48.	J. KRISTIAK Institute of Physics Dubravska Cesta 899 30 Bratislava Czechoslovakia	x		Czechoslovakia
49.	I. KUNTORO PPBMI-BATAN Jl. Babarsari P.O. Box 8, Jakarta Indonesia	x	x	Indonesia

	Name and Institute	Attended Part I	Attended Part II	Member State
50.	D. KUSNO Department of Physics FIPIA, University of Indonesia Salemba 4, Jakarta Indonesia	x	x	Indonesia
51.	N. LAKSHMANA DAS Department of Nuclear Physics Andhra University Waltair, Visakhapatnam 530 003 India	x	x	India
52.	J.-T. LEE Fast Reactor Division Korea Advanced Energy Res. Inst. P.O. Box 7, Cheong Ryang Seoul Republic of Korea	x	x	Korea
53.	U.-C. LEE Seoul National University Department of Nuclear Engineering Sinrin-dong Gwanag-gu, Seoul 151 Republic of Korea	x	x	Korea
54.	J.V. LOLICH Centro Atomico Bariloche Comision Nacional de Energia Atomica 8400 S.C. de Bariloche Argentina	x	x	Argentina
55.	C. MACIUCA C.I.U.E.M.M.R. Soseaua Berceni 104 Sector 4, Bucharest Romania		x	Romania
56.	A.R. MAJUMDER Department of Physics University of Dacca Dacca-2 Bangladesh	x	x	Bangladesh
57.	M.A. MANNAN Institute of Nuclear Science & Technology Bangladesh Atomic Energy Commission P.O. Box 158 Dacca 2 Bangladesh	x	x	Bangladesh

	Name and Institute	Attended Part I	Attended Part II	Member State
58.	D.E. MEDJADI C.S.T.N. Ave. Franz Fanon B.P. 1017, Alger-Gare Algeria	x		Algeria
59.	G. MEDRANO Division de Energia INTECSA Orense 70, Madrid Spain		x	Spain
60.	I. MELE Institut Jozef Stefan Jamova 39 61001 Ljubljana Yugoslavia		x	Yugoslavia
61.	P. MICHAELIDES Nuclear Physics Laboratory University of Athens 104 Solonos STR Athens 144 Greece		x	Greece
62.	N.I. MOLLA Atomic Energy Centre P.O. Box 164 Ramna, Dacca Bangladesh	x	x	Bangladesh
63.	J.R. MORALES-PENA Facultad de Ciencias Departamento de Fisica Universidad de Chile Casilla 653, Santiago Chile	x		Chile
64.	K. MORSTIN Institute of Physics & Nuclear Technology Akademia Gorniczo-Hutnicza al. Michiewicza 30 30-095 Krakow Poland		x	Poland
65.	D.M. NADKARNI Nuclear Physics Division Bhabha Atomic Research Centre Trombay, Bombay 85 India	x		India

	Name and Institute	Attended Part I	Attended Part II	Member State
66.	K.M. NAGUIB Atomic Energy Establishment Nuclear Research Centre Neutron and Reactor Physics Dept. Cairo Egypt	x	x	Egypt
67.	R. NARAIN Departamento de Energia Nuclear Universidade Federal de Pernambuco Cidade Universitaria 50.000 Recife, Pernambuco Brazil	x	x	India
68.	T. OHSAWA Dept. of Nuclear Engineering Kyushu University Hakozaki, Highashi-ku Fukuoka 812 Japan	x		Japan
69.	S. OGUNBUNMI Department of Physics Lagos University Lagos Nigeria		x	Nigeria
70.	L. PANGGABEAN B.P.P. Teknologi Jalan Tamrin no. 8 Jakarta Indonesia	x	x	Indonesia
71.	S.D. PARANJAPE Theoretical Reactor Physics Section 5th floor, Central Complex B.A.R.C., Trombay, Bombay 400085 India	x	x	India
72.	D. PEVEC Faculty of Electrical Engineering P.O. Box 170 41001 Zagreb Yugoslavia	x	x	Yugoslavia
73.	C. PICON Department of Physics Universidad Nacional de Ingenieria Casilla 1301, Lima Peru	x	x	Peru

	Name and Institute	Attended Part I	Attended Part II	Member State
74.	J. RAMA RAO Department of Physics Banaras Hindu University Varanasi 221005 India	x	x	India
75.	R.A. REGO CRA/IAE/EAV Sao Jose dos Campos SP 12200 Brazil	x	x	Brazil
76.	A.H. REHMAN Reactor Operation & Maintenance Group Pakistan Institute of Nuclear Science & Technology P.O. Nilore, Rawalpindi Pakistan	x	x	Pakistan
77.	M.U. REHMAN Goverrment College Hanzara Division Kanpur Pakistan	x	x	Pakistan
78.	I. RIBANSKY Institute of Physics EPRC Slovak Academy of Science 899 30 Bratislava Czechoslovakia	x		Czechoslovakia
79.	M. SABEK Neutron & Reactor Physics Dept. Nuclear Research Centre Atomic Energy Establishment Cairo Egypt	x	x	Egypt
80.	B. SAHU Physical Research Laboratory Ahmedabad 380 009 India	x	x	India
81.	L. SAJO BOHUS Universidad Simon Bolivar Dep.to de Fisica P.O. Box 80659 Caracas 1080 A Venezuela	x		Venezuela

	Name and Institute	Attended Part I	Attended Part II	Member State
82.	M. SALIH Nuclear Research Centre Baghdad Iraq		x	Iraq
83.	O.H. SALLAM Atomic Energy Establishment Nuclear Research Centre Neutron and Reactor Physics Dept. Cairo Egypt	x	x	Egypt
84.	A. SANGARIYAVANISH Department of Physics Faculty of Science Srinakharinwiret University Prasarnmitr, Sukhumvit 23 Bangkok 11 Thailand	x	x	Thailand
85.	F. SEFIDVASH Nuclear Eng. Department UFRGS Praca Argentina s/n 90.000 Porto Alegre RS Brazil	x	x	Brazil/Iran
86.	M.L. SEHGAL Department of Physics Aligarh Muslim University Aligarh (UP) India	x		India
87.	D. SERGHIUTA Institute of Nuclear Power Reactors P.O. Box 78 0300 Pitesti Romania		x	Romania
88.	V.K. SHUKLA Experimental Reactor Physics Section Hall no. 1, Bhabha Atomic Research Centre Bombay 400 085 India	x	x	India
89.	V. STANCIC Boris Kidric Inst. of Nuclear Sciences P.O. Box 522 11001 Beograd Yugoslavia	x		Yugoslavia

No.	Name and Institute	Attended Part I	Attended Part II	Member State
90.	S. SUDÁR Institute of Experimental Physics Kossuth University H-4001 Debrecen Hungary	x		Hungary
91.	M.K. SUJCZYNSKA Institute of Nuclear Research 05-400 Otwock-Swierk Poland		x	Poland
92.	M. SUMINI Politecnico di Torino Istituto di Fisica Tecnica e Impianti Nucleari Corso Duca degli Abruzzi 24 10129 Torino, Italy		x	Italy
93.	B. SZCZESNA Institute of Nuclear Research 05-400 Otwock-Swierk Poland		x	Poland
94.	E.A. TOGUN Department of Physics University of Ife Ile-Ife Nigeria	x		Nigeria
95.	H.J. TOMECKI Institute of Nuclear Research Computing Centre CYFRONET Reactor Calculation Department 05-400 Otwock Poland		x	Poland
96.	A. TRKOV Institute Jozef Stefan Jamova 39 61001 Ljubljana Yugoslavia	x		Yugoslavia
97.	K. TUNCEL C.N.A.E.M. Pk 1, Havaalani Istanbul Turkey		x	Turkey
98.	T. TURKER Nukleer Arastirma Merkezi Pk 1, Havaalani Istanbul Turkey		x	Turkey

No.	Name and Institute	Attended Part I	Attended Part II	Member State
99.	G.P. UPADHYAYA Dept. of Physics Gov. College Bareli Dist. Raisen MP India	x	x	India
100.	M. VASILESCU Institute for Nuclear Power & Reactors P.O. Box 78 0300 Pitesti Romania		x	Romania
101.	A.H. WRIEKAT Department of Physics University of Jordan Amman Jordan	x		Jordan
102.	M.I. YOUSSEF Faculty of Science Department of Physics Mansoura University Mansoura Egypt	x	x	Egypt
103.	M. ZAGONI Central Research Institute for Physics P.O. Box 49 1525 Budapest Hungary		x	Hungary