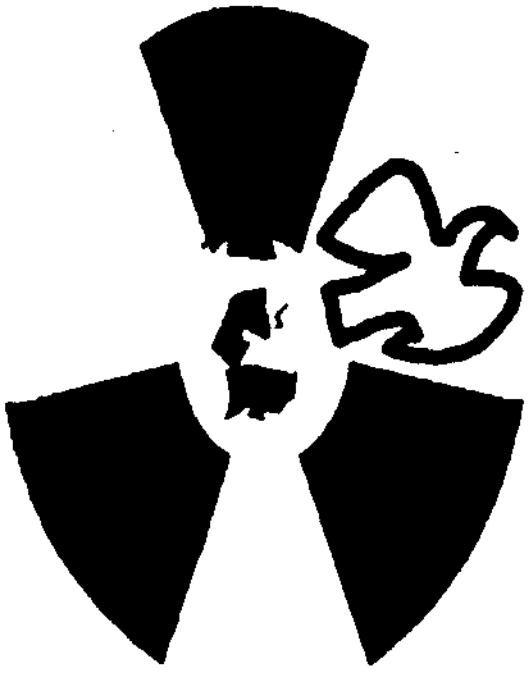

# ANUMUKTI

## A Journal Devoted to Non-Nuclear India

**Volume 6 Number 5** **April / May 1993**

**A Special Issue On**

# RAWATBHATA

# From The Editor's Desk

h ta survey took
p h September to
2 ber, 1991. It is now May 1993. A report which **we had** expected to complete in a few **months** at **the** most has taken the better part of two years. Yet, the task is not complete. What we present here is in the nature of a preliminary summary of the main conclusions. By preliminary, we do not mean that the contusions drawn are tentative and subject to change on further analysis. The conclusions are firm. But a final report would require a large amount of detail, which for reasons of economy of spare and also because we felt that it would not be of great interest to most readers of *Anumukti,* we have omitted from this narration.

We expect the full report to run to well over 100 pages. It would contain all the data along with various cross-tabulations. It would need illustration and we have a number of photographs for the production. The production costs of a properly brought out document are likely to be high. It would require a great amount of our time and effort. Although most of the analysis is already complete, the writing of the full report remains a formidable assignment. Before launching ourselves into this task, we would like to know if people are interested in the outcome. So, please write a letter to us letting us know if you are interested in buying a copy of the report. If we get more than a hundred advance orders we would certainly produce the report. In case, not many are interested, we would publish the material as a series of technical papers in various journals.

There remains the question of the language of the report. We feel **that** the information most **intimately concerns people** who do not know **English, but most people** who have the time to devote to read such reports prefer English. If we get even 25 orders for **a** Hindi version, we would **be** very happy to bring out a Hindi **version** also.

# Conclusions of the Health Survey of Villages Near Rawatbhata

- An extraordinary rise in congenital deformities
- Spontaneous abortions, still-births and one day deaths **of** new **born** babies significantly higher
- Significant increase in chronic diseases especially amongst the young. No differences in acute infections
- Solid tumours significantly higher
- A difference of more than 11 years in the average age of people who have died in the last two years
- More cancer patients and cancer deaths in villages near the plant
- Significantly lesser number of electrified household and pumping set connections near the plant

## Supreme Court Asks the Government to Reconsider Kaiga Atomic Power Project

Final hearings are in progress in the case filed by antinuclear friends in Karnataka against the Kaiga Atomic Power Project in the Supreme Court. In an interim order, the Court has asked the Government of India to reconsider the project.

Kaiga is **the** only **place in the world where a nuclear power plant is being built in the midst of a tropical rain forest. The project is a specially heinous crime against the environment.**

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# ANUMUKTI

A Journal Devoted to

Non-Nuclear India

*A special issue on*

# *RAWATBHATA*

*Conclusions*

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*contact Address:*

Sanghamitra and Surendra Gadekar
Sampoorna Kranti Vidyalaya, Vedchhi 394641 INDIA
e-mail: Admin@Anumukti.IIbom.ernet.ln

# Faustian Bargain

Nuclear technology was called "A Faustian Bargain" by AIwyn Weinberg, one of the pioneers of the field. In Faust, Mephistopheles does fulfil his part of the bargain What about in Rawatbhata?

The people of the area around Rawatbhata never made any bargain with anyone. The bargains were made in their name, in Delhi and Bombay and Ottawa. The people have certainly paid a heavy price. We would call it an unacceptably heavy price. But, what have they paid it for? What difference has this temple of modern India made in the life of Dhapo Bai of Malpura, or Bhanwarlal Bhil of Tamlav?

We must remember that RAPS was not the first encounter these people had with development. Before RAPS, there was the Rana Pratap Sagar Dam. Some of the people presently living in the villages that we surveyed are refugees from that first bout of progress. There is no doubt that the one thing that has been achieved is the destruction of the traditional way of life. We found that whereas the residents of the distant area do find employment within their villages, the people in the proximate,area are totally dependent on RAPS. Not only for employment, but also as a market for their produce and services.

Modern development means concrete things to people. Things like better roads, telephones, schools, better health care facilities, pot* able drinking water for which one doesn't have to waIk for an hour, electric lights, irrigation, etc. We found that for any of these criteria, the distant villages were either distinctly better off or certainly no worse than the villages near the nuclear power plant. We have already, in the results section, commented on the fact that while less than 20 percent of the households in the proximate area had electricity, the number of such houses in the distant area was 52 percent. Regarding potable drinking water, the Central Water Commission has given its verdict (page 28).

Let us focus our attention on the health care facilities. Till the time of the survey, there was no primary health centre in any of the five villages. This made it imperative for the villagers to go to Rawatbhata in case of any medical emergency. There were only two buses in a day plying between the villages and Rawatbhata. (Tamlav in this case is an exception, since it is situated on the main road and is consequently better connected.) Both the buses reach Rawatbhata after the primary health centre there has closed for the day. Of course, there is a modern hospital in Rawatbhata, equipped to deal with any medical problem, but its services are meant only for the 'regular staff of RAPS and not for the hoi-polloi. Casual workers at such times are not considered 'nuclear' workers and certainly not 'staff. In fact, requests by-the'public for admittance to the RAPS hospital are considered as ''attempts to blackmail" (see page 23).

From time to time, there are stories in newspapers of superstitious people who practice human sacrifice in the hopes of finding buried treasure. These stories justifiably fill us with horror not only at the gory deed, but also at the superstition. When will we feel the same horror and revulsion towards the modern superstition of development which requires many more human sacrifices?


## Acknowledgements

First of all, we would like to express our sincere gratitude and thanks to the people of Rawatbhata and Rampura areas, without whose unstinted cooperation and help the survey would not have been possible.

Young people, students and doctors from different parts of the country came for the survey, giving their time, and spending their own money. We can never forget their dedication and selflessness.

The help given by Dr Leela Visaria and the Giyarat Institute of Development Research, Ahemedabad in design of the survey was what allowed us to even think of under* taking the survey in the first place. IIa Mehta and Vinayak Dave of this institute were the coordinators of the data collection team and their professionalism was marvellous.

Rajeev, Ratna, Nivedita, and Vidya of the Network to Oust Nuclear En ergy, were responsible for recruiting the volunteers from Delhi. It was Ratna's will to see the survey through which gave us a new impetus at a time when we were feeling rather depressed.. Rajeev and Ratna did so many chores that it would take pages to just enumerate them. The role of Shri Ram Pratap Gupta of Rampura College was crucial. He made all the arrangements at Rampura and also inspired his students to join the survey team. Ms Sudha Hardikar put us all to shame with her apetite for hard work. Aradhana's meticulousness helped us maintain a uniform standard of data col* lection in both areas.

Acknowledgements cannot be complete without mentioning two names from Rawatbhata. They have already suffered so much harassment that they are immune to any further provocations. Jaan Mohammad Saheb not only opened the doors of his hotel to us, he opened the doors of his heart. And more than anything else it was the courage and the perseverance of Shri Ratanlal Gupta—Sarpanch of Rawatbhata, which carried the survey through.

# Introduction

During the 1950s and 60s, in the first flush of freedom, development came to the bank of the river Chambal in south Rajasthan. Dams were designed, barrages built, power stations put up. Kota, which used to be a sleepy mofussil town, was transformed into the industrial hub of the region. New townships sprang up. The story that follows is a story of one such 'temple' of modern India located on the banks of Chambal: Rawatbhata, the atomic town. But to bring out into full focus the assorted threads of development, it is necessary to contrast this shining new temple with an old semi-deserted ruin, another habitation just 50 km upstream on the Chambal—the town of Rampura in the adjoining Mandsaur district of Madhya Pradesh.

## The "Fall' of Rampura

The first recorded reference to Rampura in historical records occurs in 1434 AD. It is well established that even as early as 1730 AD, Rampura was a prosperous town. It was the capital of a state of 661 villages and had an income of Rs 8 lakhs. However, in the 1750s, its administrative decline started when it was annexed and made part of the Holkar state. Despite this, eighty years later, in 1830s according to Sir Malcolm Hamilton, it was a town of 4,000 houses with a population around 20,000 to 25,000- Its sworda, metal work, wood work and cotton and woolen weaving were famous.

The first major economic shock to this town was delivered by the building of the B.B & C.I. railway line. The railway bypassed Rampura which slowly lost its importance as a centre of commerce and trade. Industrialisation meant the local cottage and village industries were slowly obliterated. All this plus two severe droughts resulted in the first large scale emigration from Rampura area. The population declined by 30% in the three decades between 1890 to 1920.

The second blow to Rampura was delivered by the construction of the Gandhisagar dam on the Chambal. The hinterland of Rampura-the villages whose products were sold in its market-all went underneath the vast expanse of the Gandhi Sagar Reservoir. Rampura's population today is less than 10,000 and the vast beautiful ruins of empty houses and old havelis bear testimony to a glory gone by.

## The Rise of Rawatbhata

Rawatbhata, on the other hand is a place which prima facie has prospered under development. Like Rampura, it too is situated near a dam on the Chambal - in its case the Rana Pratap Sagar Dam. But unlike Rampura, its population during the last thirty years has grown The building of the dam was followed soon by the building of the atomic power station complex Rawatbhata was selected as the site for the first pressurized heavy water reactor (PHWR) in India in 1961 and construction started in 1964. Unit-1 achieved criticality in August 1972 and was declared commercial in December 1973. The construction of the second unit started in 1967. It achieved criticality in October 1980 and was declared commercial on April 1, 1981. The station, known as the Rajas than Atomic Power Station (RAPS), is located around 5 kilometers south of the town of Rawatbhata, on the east bank of the Rana Pratap Sagar Reservoir. All this development activity brought construction workers and later engineers, operators, security staff, etc. and their families. Many people displaced by the reservoir flocked to Rawatbhata to try their luck setting up new businesses and providing various services to the burgeoning population. Today, Rawatbhata's population is somewhere between 30,000 to 40,000. The growth is still continuing since work has started on reactors number 3 and 4, and four more reactors are in the planning stage. However, one point needs to be noted. Despite all the power generated at Rawatbhata, there is no other large industry anywhere in the vicinity. The major consumers of Rawatbhata power are the industries located at Kota, fifly kilometers to the north-east.

## Why Rawatbhata was Selected?

The -Site Selection (Committee was constituted in 1961. It was asked to select a suitable site for a 200 MW nuclear power plant in the general area of Delhi, Punjab, Rajasthan and U.P, In all, ten sites were considered. Of these, two were found unsuitable and amongst the rest Rawatbhata was found the most suitable. The criteria (or selection included availability of cooling water, the capacity and the suitability of the electrical systern, considerations of geology and seismology. The scarcity of population was a prime consideration. Some weightage was also given to other factors such as access to the site, availability of land, agriculture, daily and fishery products.

N.B. Prasad Committee which in 1982 investigated the causer for the generally poor performance of the station, agreed

**WHICH the choice of Ravarthata** as the site for the first in a series **of similar nuclear plants around the country, but expressed some unhappiness. In its own words:**

***"At the time of the selection of the site, there was very little experience with nuclear power generation anywhere in the world. Therefore the most* im-*partant guideline that determined the selection of the site was its remote location in an area of very low population density, whereby the consequences of a reactor accident would be minimised."***

***"While the site selected by the Site Selection Committee met all the criteria adopted for the selection of sites at that time, the re-***

*moteness* of *the site adversity effected the operation and maintenance of the station. Tiu logistics were not satisfactory for quickly getting the required help nor were communication facilities satisfactory. It is difficult to quantify the loss of generation due to these factors but station staff have frequently referred to these difficulties."*

# A Dismal Record

The history of operation of Rajasthan Atomic Power Station (RAPS) even when seen on purely technical grounds with no consideration for the human costs involved, is an extremely dismal one. Any objective analysis, based on criteria developed by the nuclear industry itself would also come to the same unflattering conclusion* Indian nucleocrats privately and in restricted circulation documents, admit to this sorry state. The following is an extract from the report of the Prasad Committee, which in 1982 went into the causes of this dismal performance.

*"The analysis reveals that the operating record of RAPS-1 in the eight year period (from 1974 to 1982) has been somewhat chequered. There were bad years when the unit was totally shut down for long periods due to turbine blade failures or labour unrest. Intermittently, there were periods of slightly better operation, in 1974 and 1976, when the station operated at capacity factors of 40% and 46% respectively. There was a two-year period in 1979 and 1980 when the station operation was satisfactory and the stationi reached Capacity factors of 65% and 64% respectively. This has been again followed by poor performance in 1981 and a total shut-down during most of 1982.*

The report of the committee (composed of bureaucrats from the Department of Atomic Energy and the Rajas than State Electricity Board) tries both to justify the choice of nuclear technology (in particular CANDU reactors), and simultaneously also find causes for the admittedly poor performance. It blamed the remoteness of the site, the poor communication facilities and the poor support from the grid with frequent and large fluctuations in the electricity supply, for the sorry state of affairs. In their own words:

*"In Rajastan, all these years generation consisted of hydro and nuclear units only. Thus during drought periods there was no generation except nuclear available to the entire State of Rajastan and this has brought about tremendous pressures on the station management to keep the station going even under adverse conditions when they would have been better advised to shut down the station for plant maintenance. The result has been that RAPS did not get the operating environment foreseen in the design and could not be operated with the flexibility that was necessary for a prototype power station. Rqjastan in its turn, had to depend on what turned out to be a not so reliable power source for its needs, as forced outages at RAPS were for longer periods than normally associated with conventional power stations."*

***Lifetime generation of electricity from RAPS-1 has been less than 22 percent of rated capacity, while older Canadian plants of similar design have operated at 62 percent of capacity.***

The Committee submitted its report in July 1982. It made many recommendations to improve the working of the plant. However, the crack in the South End Shield of the first unit has ended all hopes of better performance from this unit. In fact, since 1982, the unit was shut down for three whole years. (1983, '84 and '86) It has'since then, despite all efforts, produced less than 10 percent of its rated capacity. The performance of RAPS-2 has been in contrast far better. It has produced a little more than half its rated capacity. Contemporary units of Pickering Nuclear Generating Station in Canada have in contrast produced more than 90 percent of their rated capacity. Pickering is a much larger station with a capacity ten times that of RAPS.

# Routine Emissions

**(licial data regarding emissions of radioactive waste from the plant are hard to come by. There is a publication known as the "CANDU Owners Group Newsletter", published monthly, which is a compilation of official data for the use of Canadian electricity utility executives. The only information regarding the Indian and Pakistani CANDUs that is available in it concerns the amount of electricity produced during the month and the duration of time that the reactor was working. Data regarding the quantity of various kinds of waste products released into the air, water and or buried in the ground, or data on the radiation dose received by workers is not reported by the respective nuclear authorities in either country. This 'secrecy' is in contrast to the Canadians - the ones who sold us this technology in the first place - who, to their credit, do publish this kind of data.**

**Bits and pieces of such Indian data have been published and are available in obscure 'places. For example, data about releases of various radioactive**

| Year | Argon-41 TBq | Iodine-131 MBq | Tritium TBq | |
|---|---|---|---|---|
| 1973 | 367.3 | 95.3 | 25.3 | |
| 1974 | 157.7 | 287 | 87.8 | |
| 1975 | 3,959 | 1,220 | 223.3 | |
| 1976 | 3,209 | 1,450 | 545.9 | |
| 1977 | 4,026 | 5,550 | 525.4 | |
| 1978 | 1,034 | 183 | 531.9 | |
| 1979 | 4,015 | 1,900 | 1,905 | |
| 1980 | 5,393 | 5,920 | 1,117 | Annual Average Tritium Detected in a 2—10 km region Bq/m' |
| 1986 | 4,106 | 230 | 661 | 2.6 |
| 1987 | 3,959 | 547 | 1,121 | 1.1 |
| 1988 | 5,767 | 10,019 | 1,028 | 1.3 |
| 1989 | 4,267 | 19,867 | 1,471 | 0.9 |
| 1990 | 10,640 | 1,398 | 2,566 | 1.0 |
| **Comparison With Pickering Station (4320 MW)** | | | | |
| 1989 | — | 1290 | 1463 | 22 |
| 1990 | — | 410 | 908 | 17 |

Table 1: Routine Emissions **from RAPS**

gases to air through the stack, from RAPS-1 from 1973 to 1980 have been published as part of Mr K.K. Narayanan's M.Sc. thesis (title: "Population Exposure from Nuclear. Power Reactor Operation), submitted to the University of Bombay in 1983. Mr Narayanan was a member of the Health Physics Division of the Bhabha Atomic Research Centre. I am thankful to Shri R. Ashok Kumar of Bombay for the trouble he took in unearthing this data. Similarly, data regarding routine releases for the years from 1986 to 1990 haw been published in a paper en* titled "Environmental Impact of PHWR type Power Stations - Indian Experience by a team of Bhabha Atomic Research Centre scientists—IS. Bhat, M.A. Iyengar, R.P. Gurg, S. Krishna mony and K.C PiIlai which was part of the conference proceedings on Small and Medium Scale Reactors held in Delhi in 1991. I am thankful to Mr. R. Ramachandran of the New Delhi bureau of *"The Economic Times"* for bringing this paper to my notice.

But, there are serious questions regarding the reliability of the little data that is available in India. For example, the data tabulated in Table 1 regarding tritium releases for the years from 1980 to 1990 are taken from the paper by Bhat, et. al. The same paper carries the numbers given in column 5 regarding the air tritium in a two to ten km region found by measurements, carried out by the environmental survey laboratory. These authoro claim they placed monitoring equipment at various points all around the plant, which made measurements at various times in different seasons and the values given in column 5 of table 1 are the averages for the year. Howeve'r, the numbers in columns 4 and 5 do not match each other. Thus, we

have *an* anomalous. situation where column 4 says that almost four times as much tritium was released in the atmosphere from the stack in 1990 as was in 1986. On the other hand, column 5 says that the amount of tritium found in the air during 1990 was 2.6 times less than that found in 1986. The two factors taken together mean that there is a discrepancy of more than ten times in the amount of tritium released and that detected. Where has all the tritium gone? It seems at first sight to be too large an inconsistency to be accountable to factors like weather. One does not know which of these two sets of numbers, if either, to believe.

Even if we set questions regarding the veracity of the data aside, and accept the numbers as given at face value, they do show that the amount of radioactivity releases made by our reactors are far higher in than the Canadian CANDUs of similar design and age. The Pickering Nuclear Generating Station (PNGS) consists of eight reactors, each of 540 MW capacity. Four started during 1971 to 1973, that is a little before the startup of RAPP-1. The other four started from 1982 to 1985, a little after RAPP-2. Four reactors of 540 MW mean a total generating capacity of 2,160 MW. Thus, the electricity generation capacity at Pickering has on an average always remained more than ten times that of RAPS. The life time load factor (the ratio of the electricity actually produced to what the station would have produced if it had worked at full capacity all the time) has been 67% and 84% respectively. For comparison, RAPS-1 has a lifetime load factor of 22% and RAPS-2 of 54%. This means that the Pickering station has over the years produced well over 20 times more electricity than RAPS. The radioactive tritium releases in the air have during recent years been greater at RAPS than at Pickering. The numbers for 1989 and 1990 are presented in **table *2.* Thus, the unaccounted pollution burden** of **RAPS electricity is at least twenty times and sometimes** even **(as in 1990) fifty times higher than that of electricity from** Pickering. **Similar** comparisons with newer Canadian reactors would he even more adverse for RAPS.

But tritium emissions to the air is just one kind of radiological pollution. One might ask

*The radiation burden on the workers at RAPS is at least eight times as much as that on the workers at Pickering though in 1990 Pickering produced 50 times more electricity than RAPS*

about other radioactive poisons like iodine-131. A comparison of RAPS with Pickering data show that the released amount in both cases is of the same order of magnitude. There is no mention in the Pickering data of Argon-41, whereas this radioactive gas is the largest component of the poisonous combination emitting from the RAPS stack. Although Argon-41 has a short half-life, a huge amount of it is being released, so it contributes very significantly to the radiation dose being received by the public in the vicinity of the plant.

Other parameter's can be used to determine the comparative dirtiness of plants, such as, the total radiation dose received by workers. The Canadian plants publish this data regularly. The numbers for RAPS were also published earlier. But since 1979 the authorities no longer publish such information even in nuclear industry journals abroad where, a lot more useful information about the Indian nuclear programme appears then is ever published in the 'Desi' press. **The format for reporting this dose makes separate columns for regular employees and contract labour. However; except for one year, (1976when the dose at RAPS-1** was **650 man-rem for regular employees and 150 man-rem for contract workers), the Indian authorities did not publish these** figures separately, but rather gave a combined figure. This figure hovered around 800 to 900 man-rem. In 1989 Dr. A.K. De, then chairman of the Atomic Energy Regulatory Board, made an announcement in the newspapers stating that the radiation dose to **workers at RAPS** and **MAPS** was **unacceptably** high at 1700 man-rem and he had recommended that the dose be brought down to 1000 man-rem. RAPS had been ordered closed **for** a **few** days because of this. Apart from this newspaper report there has been no other reference that I have come across which gives the total radiation dose to workers. It is not clear from the newspaper report whether 1700 man-rem is the dose due to both the reactors or if it is the dose due to each reactor. I suspect the latter, since prior to 1980 RAPS consisted of only RAPS-1 reactor and a dose of about 850 man-rem had not rung any alarm bells then. Another point which is not clear at all is whether this dose is the external dose received by workers or if it includes the internal dose absorbed by workers through inhalation of tritium and other radionuclides. The Canadian data makes a distinction between these two categories of radiation doses. However, even if we give the benefit of the doubt **to RAPS, and take** 850 **man-rem as the total (internal + external) dose at each reactor, this figure is eight times as high as the dose at Pickering. The Pickering dose is 111** man-**rem per reactor. As I mentioned before the Pickering reactors** have been **in** operation **the same amount of time as RAPS and produce twenty times more electricity.**

# The Survey

*Some of the material in this section has appeared before in "Anumukti"(See "Anumukti" Vol.3 No.6 and Vol.5 No.4). We are including it here in the interest of completeness. However, those who have seen this before can skip this section and go directly to results. A summary of the methods is presented for convenience.*

We first went to Rawatbhata in April, 1990 at the invitation of the Parmanu Pradooshan Virodhi Sangharsh Samiti, a body formed by Sarpanches of ten villages around Rawatbhata. Despite the name, this was not an antinuclear group. The invitation to us was the proverbial clutching at straws when drowning. They had originally invited us a year earlier, but had later canceled the invitation. This cancellation had been done because the RAPS (Rajasthan Atomic Power Station) authorities had promised to look into their complaints on the condition that they would cancel their invitation to anti nuclear groups to come to Rawatbhata.

Their demands were the usual demands of people with respect to development projects: When would we taste the fruits of development? They wanted jobs, schools, roads, access to medical facilities, etc. One of the points they made was the fact that even after 17 years, the village on whose land the reactors had been built, (Tamlav) had yet to receive electricity connections. (See Sunils article *Rawatbhata: Development Brings Dissatisfaction* in *Anumukti* Vol.3 No.5, April, 1990)

**Our report about the visit** *(Chernobhata?)* **was** published **in *Anumukti* Vol.3 No.6, June, 1990. It received a good amount of national and some international publicity. Since then, other newspapers sent reporters and photographers to the area and they have published a number of reports. A British journalist, Christopher Mitchell made a** clandestine film, "The Price of Power", which was shown on Channel-4 in Britain on April 2, 1991. Excerpts from this film along with an interview with the Secretary of the Atomic Energy Regulatory Board (AERB), Dr K.S. Parthasarathy, were shown in the September 1991 edition of "Eyewitness"—a videomagazine brought out by *Hindustan Times TV.* The release of this video caused quite a comfnotion, with questions being asked in the Parliament and the subject remaining in the news for many consecutive days.

## The Basic Difficulties

For more than a year we had been trying to persuade various independent organisations with expertise in the matter to conduct a door-to-door survey of the area. We felt diffident about doing the survey ourselves since we had very little expertise and virtually no resources to undertake this task. Unfortunately no organisation came forward to do this work on their own. Some organisations, who did show an interest, wanted to submit project proposals and get approval and grants from the government before proceeding However, government approval essentially means approval from Department of Atomic Energy (DAE). The DAE has been notorious for delaying grants and approval for such surveys. For example, they delayed for five years before giving grants to South Gujarat University for making a baseline health survey of the area around the Kakrapar nuclear power plant.

At the same time there were reoeated requeste from the people around Rawatbhata which promised all possible help in carrying out the survey. At the Bangalore meeting of antinuclear groups in April 1991, (See *"Anumukti"* Vol.4 No.6) there was strong support for the idea of conducting the survey. All these things together helped us decide to do the survey ourselves.

Not having done such a survey before we were ignorant of the difficulties involved and had no inkling of the different kinds of organisational skills required Now that the survey is done, we don't mind admitting that without expert help there is a good chance that we would have made a fine mess of things but fortune favoured us and we had a very lucky break is the form of a chance meeting with Dr Leela Visaria of the Gujarat Institute for Area Planning. She not only helped in the design of the survey schedules but also sent two absolutely invaluable investigators to help conduct the survey. Shri Vinayak Dave and Ms. IIa Mehta not only taught us a good deal but also took care to see that the survey was properly conducted and no household inadvertently left out We also received expert help from a team of eight doctors from various parts of the country who came and helped with the diagnosis of serious conditions.

The second great constraint was money. We cyed with the idea of applying for .a research grant, but gave that up due to considerations of the time and effort involved. Then we had a happy thought First of all reduce expenses to the absolute

burden so that no single entity gets too much of a load. It was decided that all investigators would volunteer not only their time and energy but also contribute their traveling expenses; boarding expenses would be the responsibility of our local hosts at Rampura and Rawatbhata; expenses such as publication of schedules, medicines and other equipment would be borne by the *"Anumukti"* group. We made an appeal for both volunteers and donations. The response was overwhelming and far beyond our expectations.

## Methodology

Ideally, what one needs in a comparative survey are two populations which are similar in each and every respect, except as regards to the effects of the factor being studied. For a case like Rawatbhata, the best course would have been to have done a baseline survey before the plants were set up, and then to have repeated the same survey using the same methodology a few years later. This way, one could have compared the two, and if the setting up of the plant had resulted in any adverse health effects, these effects would have become apparent. Unfortunately, this course is not now open as the authorities did not do any baseline survey of the area before the plants began operation. In fact, even today new plants are being set up and the authorities have still not felt the need to do any kind of basic health survey, on the specious excuse that it is not a requirement for other hazardous industries.

The next best course is to do a comparative health survey of two similar populations. Obviously, it would not be sensible to compare the disease and deformity pattern of a population living in high rise apartments on Malabar Hill in Bombay with those of villagers around Rawatbhata, since the pattern would be different due to differences in lifestyle, genetic pool, environmental and stress factors, etc. The similarity of two populations is a difficult condition to meet, since there are so many factors which can vary between populations. The criteria used for selection are described in the following section.

## Criteria for Selection

All the villages which were in the north-east direction of the plant within a ten kilometer radius were selected for the survey. We chose the north-east direction since during the monsoons, the wind direction is from the south-west towards the north-east. Logic dictates that if the routine air emissions of radioactivity from the plant were causing any adverse health effects in the surrounding area, then the effect would be most pronounced in the north-east direction, due to settling of radionuclides through rain. There were five villages in all (Tamlav, Deeppura, Malpura, Bakshpura and Jharjhani), which satisfied this criterion, with a total number of 551 houses and a population of 2860. Except for Tamlav, which lies closest to the plant, all the other villages are situated in a valley called the Kundal. Deeppura and Malpura lie just at the head of the valley, where it has narrowed down to almost a canyon, while Bakshpura and Jharjhani are further insiden the valley. There are other villages more distant from the plant or in other directions from the plant. But we did not include them in the survey for two reasons. Firstly, we had adopted the criteria of wind direction during monsoons and a distance of ten kilometers from the plant as the basis for selection and we did not want to deviate from this criterion. Secondly, to have included more villages would have meant substantially increasing the size of the population covered. That

would have made the survey
well beyond our capabilities.

For the sake of comparison, we chose the four villages of Khetpalia, Dhoodhlai, Anandipura and Chandrapura near Rampura in Mandsaur district of Madhya Pradesh. These four villages are more than fifty kilometers distant in the south by south-west direction. The total number of households were 472 and the population was 2544. The choice of the comparison distant villages was dictated by the fact that they were located in a very similar geographical setting — near another reservoir on the Chambal and near a small town. There was no other large industry in the neighbourhood of these 'distant' villages and the pattern of motorised vehicular transport was also very similar. Obviously, we could not have chosen the control villages much closer to RAPS, since then one would not be able to discount the effect of the plant, but neither could we choose villages much further away since then the geographical and socio-economic pattern would have been much different in the two areas.

The data that was collected provides information not only about people's health but also data like where they were born, educational status, employment, births and deaths within the last two years, pregnancy histories of all women of child-bearing age, land holdings, fertilizer and pesticide use, animal holdings, nutritional status, etc. Thus, we wanted not only to compare the health of the people in the near vicinity and those farther away, but also try to see what positive difference this giant nuclear enterprise had made to the economic status and prospects of its neighbours. We also wanted to confirm if the two populations were indeed comparable as hypothesized.

## The Volunteers

Volunteers came from different parte of the country, but they all shared one quality—unbounded vigour and enthusiasm for work. It was indeed a revelation to see this kind of dedication. There was one group of 18 college students from Delhi, some of whom were post graduate students. The other large group' was students from Rampura college. There were two volunteers from Hoshangabad, and a group of eight doctors— two from Delhi, one from Gwalior and the rest from different parts of Gujarat who came for the last few days and helped by diagnosing the different ailments of the patients. Besides these volunteers, who did the actual work of data collection, there were many other local youths who helped by looking after us, bringing us food, interpreting and in various other ways.

## The Nitty Gritty

Each and every household in the selected villages had to be identified first. To do this every house was numbered. Since we wanted the numbering to last for sometime in case a revisit was needed later, a small metal numbered disc was nailed to the front door of every house. Next, a volunteer wrote down the name of the head of the household and the total number of family members. A third person would at the same time draw a map of the village and place the house in the context of the map. All this had to be accomplished before any survey questions could be asked. Sometimes even this seemingly straightforward task could present unexpected difficulties. In Deeppura one day, all of un were astonished to see a group of people emerging from what looked like a field of tall corn. further enquiry revealed that We had completely missed four,'houses since they did not ha\e any visible entrance, being surrounded by
fields on all sides*

The numbering had to be logically consistent and the logic had to be apparent to someone who had not participated in the numbering process. Remark ably, this was accomplished so successfully that later on some villagers approached us with a request for a copy of our list, because they said the village pa richayat numbering was inaccurate and inadequate and they would prefer to adopt our more systematic approach

For the filling of survey schedules, a team consisting of a male and female volunteer each was assigned houses according to the map. Quite often there would be nobody at home and repeated visits had to be made. We had to reach the village almost at dawn since by 7:30 a.m. most folk would leave for work. Thus, the most productive times were early mornings and late evenings. Women in the family were the more crucial contact since only they could give us details of pregnancy history. Since women are the most overworked group, having to work both in the field and at home answering our persistent and seemingly never-ending questions was an additional imposition. But they cooperated and answered all the questions with exemplary forbearance. Sometimes, especially initially, there were communication problems due to the local Mewari dialect, but luckily most local youth did follow and speak Hindi and after a few days the volunteers had picked up enough to get by.

## A Typical Day

day would begin usually around 4:30 in the morning, as we had to get ready and catch a bus or hitchhike on trucks to reach the villages early enough. The house numbering, listing and map making team would start on a new village while the scheduling team would fill schedule* in previously numberd and listed area. Sometimes villagers mistook us for people who would provide them with land deeds. In these cases, the false hopes had to be removed. There were times when people refused to answer any questions. In such cases one had to explain to them what the survey was about and persuade them. At times this could be a severe test of persuasive skills. Rut finally, there wasn't a single instance where a family did not consent to answer questions.

An air of uncertainty hung regarding meals, though our hosts in Rawatbhata went to extraordinary efforts to provide us food on time. I don't think anybody ever went hungry, but lunch wasnt something you could count on.

A lot of time was spent walking long distances during repeated visits to a house whose residents had gone out for work. Vinayak had the most work, since he had to keep the whole thing coordinated, distribute new house numbers to those who were unable to locate people in their assigned houses and then keep track that no house was left out and that there was minimum duplication.

By the time we returned to Rawatbhata in the evenings, hitching a ride back on trucks, it was around 9:00 p.m., and all of us were dead tired. A bath and dinner and most of all sleep was a welcome prospect However, before one could go to bed, one had to complete anything left unfinished in the schedules and also meat together to discuss the problems encountered during the day and decide on the next day's assignments. We rarely managed to get to bed before midnight.

Initially there was some cub ture shock, since city-volunteers had previously little experience of the extrte

poverty and the lack of sanitation in the villages. But the warmth with which the villagers welcomed us soon won us over and we decided to stay in the villages to avoid transportation hassles. We were treated so well that we felt like baratees' and ate some of the tastiest meals we had ever eaten.

Our best memories of the survey are connected with the truck rides back to Rawatbhata in which there was a lot of singing and some incredible feats of balancing on a fast moving truck without any kind of hand-holds. It was this spirit of bonhomie and unfailing good cheer that has established strong feelings of comradery between all of us.

The days spent at the survey counting diseases and watching stark poverty face to face and contrasting this scene with the monster development project nearby was the best possible education for the volunteers on the 'benefits' of nuclear energy. Any 'free' time was spent discussing all aspects of nuclear energy production and distribution. It was without doubt the best nuclear energy awareness camp that I have ever attended.

## A Special Problem

Despite earlier fears to the contrary, there was no direct attempt by the authorities at stopping the survey. However, there were rumours and scares aplenty. Informers were a constant bother. Probably the reason there was no direct attempt at stopping the survey was the fortunately bad relationship between the RAPS bosses (their overbearing attitude hasn't made them loved) and the local administration. However, this is just speculation on our part. The RAPS authorities did succeed in forcing the local administration to take some 'action'. This action consisted in putting pressures on our local hosts, who were repeatedly harassed.

## The Last Days

After completing the work at Rawatbhata we went to work at Rampura. The work here was just as busy as Rawatbhata. but it was easier and better organised. Our local hosts had arranged for a vehicle, so getting to and fro from the field area was no longer such a hassle.

The team of Doctors from various parts of the country came near the end of the process of data collection. We wanted them to check all the serious cases which had been identified in the survey and confirm the diagnosis. The doctors not only went to every house diagnosing, they also had to distribute medicines and to listen to all kinds of complaints. The data collection process had lasted from 4th of September 1991 to 22nd of September 1991.

Data collection was just the beginning. Next came analysis. The schedules had to be put in a computer ready format. We are very grateful to the team of computer operators at Gujarat Institute of Development Research for entering the data into the computer. The process of analysis and understanding required a lot of interaction with the computer and while the computers were at Ahemdabad, we were at Vedchhi. Frequent travels to and fro took a lot out of us. Fortunately, at this stage, our appeal for the donation of a computer was answered and we were able to start analysing the data in right earnest. Another lucky break was receiving a copy of a computer programme brought out jointly by Centre for Disease Control in Atlanta and the World Health Organisation called EPI-5 which was especially useful in doing the analysis.

## Summary of the Methodology

Each and every house in the survey was visited by a team of two (one male and one female) investigators, who filled the precoded schedule consisting of questions pertaining to various demographic data; economic and educational status; disease and immunisation; land and animal holdings; irrigation; pesticide and fertiliser use; employment patterns; family size; births and deaths during the last two years; pregnancy outcome of all women in the reproductive age-group; etc. Twenty percent of the households were randomly selected for additional information on dietary intake. Authenticity of the data collection was checked by random revisits by another team consisting of a demographer and a physician.

It needs to be noted that both" the proximate as well as distant' villages are rural areas of Central India far away from metropolitan centres. Any visit by a large team of 'outsiders' in such an area is a socially significant event. Although the questions were put separately by the investigators to adult male and female respondents, usually the whole family was in attendance and very much a part of the process. The investigators were thus able to see and verify for themselves any obvious case of deformity or serious illness.

In all cases where the investigators reported a deformity or a serious long term illness whether congenital or acquired, this was later confirmed and classified through clinical examination by physicians. However, no radiological or laboratory examinations were carried out.

***April / May 1993***

# Results

First of all, let us find out if the two selected populations are indeed comparaole. To do this, we will look at a number of parameters like age and sex distribution of the population, caste composition, educational status, diet and nutritional status, land and animal holding patterns, employment, housing, general living conditions and social habit indicators like the age of marriage and child-bearing, etc.

## Age, Sex and Caste

Data regarding age and sex distribution and caste composition are presented in Tables 2 and 3 respectively. What these tables show is a pattern of similarity in both areas. The age and sex distribution show no statistical differences at all. The caste composition on the other hand does show some variation in the two areas with scheduled tribes and upper castes being a little more in the proximate villages and the backward castes being more in the distant villages. Scheduled castes percentages in both the areas are equal. An examination of the subcastes (jatis) also reveals some likeness, with the same subcastes being represented in both the areas.

## Education

The educational pattern (Table 4) too shows singular uniformity. More than 70 % of the people in both areas are illiterate. The distant villages have a slightly greater proportion of people who have studied until class VII at school. In the proximate villages those who do study seem to study a little longer. It needs to be emphasised that the numbers do not show any statistically significant variation in the two areas. The sex wise differentiation of this data does not throw up any kind of variation in the pattern of the two areas.

| Age Group | Proximate Villages | | Distant Vlllages | |
|---|---|---|---|---|
| | Males | Females | Males | Females |
| 0 — l year | 63(2%) | 57(2%) | 43 (2%) | 55(2%) |
| 1 — 4 years | 136(5%) | 134 (5%) | 126(5%) | 122(5%) |
| 5 —14 years | 393(14%) | 370(13%) | 356(14%) | 359(14%) |
| 15 —24 years | 284 (10%) | 283 (10%) | 216(8%) | 222 (9%) |
| 25 —34 years | 220 (8%) | 196(7%) | 176(7%) | 180(7%) |
| 35 — 44 years | 141 (5%) | 122 (4%) | 140(6%) | 108 (4%) |
| 45 — 54 years | 104 (4%) | 100 (3%) | 79(3%) | 89 (3%) |
| Over 55 years | 150 (5%) | 107 (4%) | 145(6%) | 128(5%) |
| Total | 1491 (52%) | 1369(48%) | 1281 (50%) | 1263 (50%) |

The percentages i been rounded off in parenthesis to the whole numb in this and subsequent ables have tar.

| Caste Group | Proximate Villages | | Distant Villages | |
|---|---|---|---|---|
| | Males | Females | MALES | Females |
| Scheduled Tribes | 162 ( 6%) | 131 ( 5%) | 151(6%) | 165(6%) |
| Scheduled Castes | 421(15%) | 371(13%) | 268(11%) | 263(10%) |
| Upper Castes | 202(7%) | 188(7%) | 103(4%) | 87(3%) |
| Backward Castes | 703(25%) | 674(24%) | 755(30%) | 745(29%) |
| Muslims | 3(0%) | | 4(0%) | 3(0%) |
| Total | 1491 (52%) | 1369 (48%) | 1281 (60%) | 1263 (50%) |

**Table 3: Caste Composition**

| Qualifications | Proximate Villages | | Distant Vlllages | |
|---|---|---|---|---|
| | Males | Females | MALES | Females |
| Illiterate | 877(31%) | 1214(42%) | 681 (27%) | 1118 (44%) |
| Up to Class 6 | 368(13%) | 118(4%) | 412 (16%) | 128 (5%) |
| Up to Class 10 | 216(8%) | 34(1%) | 163 (7%) | 17(1%) |
| Up to Class 12 | 24 (1%) | 3 | 16 (1%) | 0 (0%) |
| More than Class 12 | 6(0%) | 0(0%) | 4(0%) | 0(0%) |

**Table 4: Comparative Educational Status**

| Cotegory | Proximate Villages | Distant Villages |
|---|---|---|
| 1 Energy | 2474 ± 991 cal | 2405 ± 784 cal |
| Protien | 80 ± 30 gins. | 79± 27gma |
| Carbohydrates | 448 ± 159 gms | 457 ±156 gms |
| Fate | 32 ± 25 gms | 27 ± 16 gms |
| Calcium | 549±346 mg | 522 ± 275 mg |
| Iron | 38 ± 35 mg | 39 ± 37 mg |
| Vitamin A | 778 ± 698 mg | 257± 1904 mg |
| Vitamin C | 13 ± 20 mg | 24 ± 34 mg |

**Table 5: Per Capita Dietary Intake**

| | Proximate Villages | Distant Villages |
|---|---|---|
| Family Size | 5.19 ±2.66 | 5.39 ±2.67 |
| Women Head of House | 5.4% | 5.5% |
| Av. Pregnancies | 5.30±2.09 | 5.15 ±2.16 |
| Woman's Age at: | | |
| Effective Marriage (Gauna) | 15.1 * 2.0 years | 15.4 ± 2.5 years |
| Birth of First Child | 18.4 ± 3.1 years | 19.3 ± 3.2 years |
| Live-Birth | 23.7 ± 5.7 years | 24.0 ± 5.5 years |
| 1 Abortion | 23.1 ± 5.9 years | 21.5 ± 5.2 years |
| Still-Birth | 22.8 ± 7.0 years | 22.0 ± 6.7 years |
| Birth of Deformed Child | 25.2 ± 5.8 years | 23.8 ± 4.9 years |
| Av. Number of Children Born to Women Aged 45—49 Years | 6.3 | 7.1 |

**Table 6: Maternity Indeces**

## Nutrition

**Another point of striking similarity between the two areas is the diet. (Table 5) The questions regarding diet were asked to a randomly selected 20 percent sample in both the areas. The question asked related to the food intake of the previous day. Different families had naturally eaten a variety of foods and also the amounts eaten were widely different. There were families who had fasted that particular day and others who had feasted. A pattern of per capita (considering an adult male as a unit and multiplying other members of the family by appropriate factors), nutritional intake for each area was calculated using the standard nutritional tables and procedures. The results show that the average nutritional status of x>th the areas is identical We have calculated not only the average caloric intake in each area, but also the intake of proteins, fats, carbohydrates, vitamins A and C as well as minerals such as calcium and iron. The averages in both places of *the* caloric intake show that the *met* is the same as the average dian diet. There was a near total absence of green leafy vegetables and fresh fruit in the in diet of the proximate villages. This might be a seasonal phenomenon. Absence of fruits and green vegetables in proximate villages' diet accounts for the differences observed in the vitamin A and C intake. The variation in the intake within each area is far larger than the differences between the two. The differences in the vitamin intake in the two areas cannot account for the wide variation seen in the health pattern (seo below).**

Differences observed in the health pattern cannot be due to deficiencies in diet. The mean caloric intake is the same as that of the average Indian diet.

## Maternity Indices

Table 6 tabulates various indices, related to women, like average number of pregnacies., average family size, age of the women at marriage and at the birth of the first child. The average age of women at the time of miscarriages, birth of a still born child and of a deformed child are also tabulated. These numbers are uniform in both areas. The numbers are important since they show that the differences observed in untoward pregnancy outcome, especially in the case of congenital deformities, cannot be attributed to factors like differences in the age of child bearing.

## Living Conditions

The housing conditions in both the areas are quite comparable. Over 80 percent of the houses are mud construction Teutons' houses and only around ten percent of the houses are brick or stone 'pukka' houses, with a permanent roof. The other ten percent in both areas come somewhere in between, with some parts built in stone and the rest in mud. The size of the houses (number of rooms) is also alike in both the areas.

However, there is a significant difference in the number of houses having electricity. Surprisingly, while only 20 percent of the houses near this 'electricity producing' atomic power plant have electricity, the percentage in the far- off villages is 52 percent.

Three fourths of the people (74.1* in proximate villages and 76.4% in distant villages) are livestock owners, mainly sheep, goats, cows, bullocks and buffaloes. In both areas the number of large cattle owners (more than 15 animals) are similar (15*). While cows are prefered in the proximate areas, buffaloes are favoured in the distant region.

Another parameter we looked at was the amount of time spent in getting drinking water and the type of water supply arrangement (Table 7). More households (66.5 %) in nearby villages get their water within a five-minute walking distance than those in far-off villages (52 *). But, at the same time, more also need to walk an hour (10.9 *) nearby than faroff (7%). Water supply arrangements (Table 7) show that while ten percent of the people get tap water, nearly two percent of house holds (all in Tamlav) still go to the pond for their drinking water (see discussion section below).

| | Proximate) Villages | Distant Villages |
|---|---|---|
| **Housing Condition** | | |
| One room | 61.2* | 56.1% |
| 2 to 4 rooms | 37* | 41.6* |
| 4 rooms or more | 1.6* | 2.3* |
| 'Kutcha' Houses | 85.3* | 82.5% |
| Electrified Houses | 19.93* | 52.02* |
| **Water Supply** | | |
| Well | 59* | 71.3% |
| Hand pump | 28.6* | 28.2% |
| Water Tap | 9.8* | — |
| Pond | 2* | — |
| 5 Minutes Walk | 66.5* | 52% |
| 15 Minutes Walk | 21.4* | 40.8* |
| 1 Hours Walk | 10.9* | 7* |

| | Proximate) Villages | Distant Villages |
|---|---|---|
| **Housing Condition** | | |
| One room | 61.2% | 56.1% |
| 2 to 4 rooms | 37% | 41.6* |
| 4 rooms or more | 1.6% | 2.3* |
| 'Kutcha' Housee | 85.3% | 82.5% |
| Electrified Houses | 19.93% | 52.02* |
| **Wote* Supply** | | |
| Weil | 59* | 71.3% |
| Hand pump | 28.6* | 28.2% |
| Water Tap | 9.8* | — |
| Pond | 2* | — |
| 5 Minutes Walk | 66.5* | 52% |
| 15 Minutes Walk | 21.4* | 40.8* |
| Hours Walk | 10.9* | 7* |

**Table 7: Housing Conditions and Water Supply**

**ing sets in the remote area (57% irrigated land) than around Rawatbhata (39.3% irrigated). Households in the far away villages use more fertiliser and pesticides than those near Rawatbhata. There are significantly larger number of pump set owners in distant villages (139, 29.4%) than in proximate villages (38, 6.9%). This fact too highlights the anomaly that those living near the electricity producing plant are deprived of the benefits of power.**

| Work Category | Proximate Village* | Distant Villages |
|---|---|---|
| Employer | 0.5* | 0.2% |
| Self Employed | 27* | 19% |
| Assistant | 8* | 12% |

| | |
|---|---|
| Labourer | 13* |
| Salaried Employee | 2* |
| Unemployed | 1* |
| Housewives | 9* |
| Students | 9* |
| Children | 27% |
| Retired | 1.5% |
| Disabled | 0.2% |

**Table 8: Employment Status**

## Land Holding and Agricultural Practices

The land ownership pattern shows that more households in the proximate area are land holders. While 75 percent of households nearby own some land, the number of such households in the far villages is only 66 percent. There are far mora landleas people in distant villages than in near villages. However, if we look at the amount of irrigated land the figures are reversed. There is a much higher degree of irrigation and availability of electrified pump-

## Employment

**The employment pattern (Table: 8) mirrors the land holding. More people (34.8% vs 31.5%) are self employed (mainly family farms) in the near villages as compared to the far villages where the number of labourers and assistants is a little larger (15% to 18.4%). Amongst the other categories we find that salaried employees and those employing others are more in near villages than in the remote onus. The absolute numbers are small in these cases. On the other hand, there are more retired people in the distant villages. Except for these small differences, there are no differences at all between the two areas with the proportionate numbers of children and students, housewives, unemployed and disabled being exactly the same.**

**The major difference is the proximity of RAPS. More detailed breakup of the category of labourers and salaried employees reveals that while over 99.5% of those in the distant area are employed in the village itself; in the proximate area 44% find work in the Anushakti complex. By Anushakti complex, we mean the campus consisting of operating nuclear reactors of RAPS—1 and 2, the Heavy Water Plant, and the new construction sites for RAPS—3 and 4.**

**Let us consider salaried employees first. Out of a total of 51 such persons, only eight have got work in RAPS and one in Heavy Water Plant. Of these nine, (all males, by the way), live were outside migrants who were not born in the area. The whole Anushakti complex—this giant development project with an investment of hundreds of crores in the past, and thousands of crores of new investment in RAPS-3 and RAPS-4—was resulted in regular salaried Jobs for just four local people in these five villages.**

RAPS has provided far more work for 'casual' workers. These casual workers are not casual in the sense of being intermittent, but rather are regular workers who are employed through the agency of labour contractors. The number of these labourers varies seasonally depending upon the work available at RAPS, but during the survey half the labour force (190 out of 381) was working at Anushakti We were told that due to a slowdown in construction of Units three and four during the time of the survey, this percentage was on the low side. The need for contract workers is greatest when the construction work is proceeding normally and there is shutdown in the operating reactors (Units one and two). Contract workers are used a lot during cleaning.

Over 40% of the labourers are people who have not been born in the area. In contrast to the case of regular employees, women form a substantial proportion (over 40 percent) of the labourers. 49% of the women labourers were born outside the area and have come after marriage. However, 36% of the male contract workers are migrants from outside.

The most shocking aspect of work at RAPS is the recruitment of child labour. We found that 8% of all the contract labourers from the survey area were children under the age of 15. Boys during puberty are especially vulnerable to radioactive pollution since that is the time when their testes are maturing and any damage to the embryonic cells can have lifelong consequences in terms of untoward pregnancy outcomes. Almost all the women who work at RAPS complex are in their reproductive period. Developing fetuses especially during early pregnancy, are most vulnerable to radioactive hazards.

## A Good Match

On the basis of the information given above we can confirm that both the areas are equivalent and therefore comparable. There are some significant differences, but these are not differences of lifestyle, rather are differences mainly associated with development (see section on discussion). The similarities between the two areas are striking and are in great contrast to the large differences that we observe in the disease, deformity and mortality patterns (see below).

The practice of child contract labour in nuclear plants is reprehensible. Pregnant and lactating mothers and young children should not be allowed to work within the premises. The poor are driven by poverty to seek a livelihood even in the most dangerous work. But should the authorities not bemore concerned regarding the long term consequences

## Health Indicators

The first and the most conepicuous difference that one finds in the health of the two areas is that considerably more people complain of ill health in proxirhate villages and they complain about a larger number of ills. Despite this, most interestingly, a majority of the population of the proximate area said that they had no health problems at all. While 25 percent of the population in the remote villages had at least one health related complaint, the percentage of people around RAPS was 44.6%. If we look at households as a unit, we find that while there were 160 households out of 472 in far villages (Rampura area) who did not report any sickness, and 25 families all of whose members reported at least one sickness, the numbers in the case of near villages were 91 and 80 respectively (out of 551). This tendency towards greater sickness in the proximate villages becomes more apparent as we look at complainants with larger number of problems. For example, there are 68 households with at least one person complaining of four separate problems in near villages, whereas the number for the far villages is nine.

Another interesting observation is that there are some types of complaints where no statistical differences in number of affected persons between the two areas were found..These jnclude short duration fevers, breathing difficulties and conjunctivites (see Table 9); there were no differences observed in the patients with hospital confirmed diagnoses of heart disease and diabetes. The number of such patients with confirmed hospital records (in both the areas) were very few.

In contrast, there are other types of complaints where we find huge differences between the number of affected persons. The incidence of chronic prob-

### Table 9: Disease Prevalence

| Typo of Slckness | Proximate Villages | Distont Villages |
|---|---|---|
| Short Duration Fover<br>Affected Persons<br>Average Age | 137 (4.8%)<br>24 * 19 years | 117 (4.6%)<br>26 ± 19 years |
| Breathing Difficutties<br>Affected Persons<br>Average Age | 71 (2.5%)<br>46 years | 52 (2.0%)<br>48 years |
| Persistant Cough<br>Affected Persons<br>Average Age | 103 (3.6%)<br>31 * 19 years | 60 (2.4%)<br>42 ± 22 years |
| Long Duration Favors<br>Affected Persons<br>Average Age | 120 (4.2%)<br>26 ± 17.6 years | 41 (1.6%)<br>30 * 17.5 years |
| Body Ache<br>Affected Persons<br>Average Age | 126(4.4%)<br>34 ± 15 years | 23 (0.9%)<br>33 ± 16 years |
| Pain in Joints<br>Affected Persons<br>Average Age | 116(4.1%)<br>43 ± 15 years | 5G (2.2%)<br>45 * 16 years |
| Digestive Problems<br>Affected Persons<br>Average Age | 360(12.9%)<br>29 ± 18 years | 151 (6.0%)<br>33 ± 19 years |
| Weakness & Debillty<br>Affected Persons<br>Average Age | 147(5.1%)<br>36 ± 17 years | 96 (3.8%)<br>46 ± 18 years |
| Skin Diseases<br>Affected Persons'<br>Average Age | 208 (7.3%)<br>21 ± 19 years | 76 (2.9%)<br>21 ± 20 years |
| Solid Tumours<br>Affected Persons<br>Average Age | 30(1.1%)<br>41 ± 21 years | 6 (0.2%)<br>60 ± 18 years |
| Eye Problems<br>Affected Persons<br>Average Age | 51 (1.8%)<br>39 ± 21 years | 20 (0.8%)<br>42 ± 13 years |
| Conjunctiviest<br>Affected Persons<br>Average Age | 16 (0.6%)<br>15 ± *17* years | 12 (0.6%)<br>12 a 12 years |
| Cataract<br>Affected Persons<br>Average Age | 21 (0.7%)<br>58 ± 15 years | 8 (0.3%)<br>68 ± 7 years |
| Acquired Defromities<br>Affected Persons<br>Average Age | 31 (1.1%)<br>41 ± 15 years | 17(0.7%)<br>48 a 18 years |
| Polio<br>Affected Persons<br>Average Age | 24 (0.8%)<br>21 a 18 years | 17 (0.7%)<br>21 ± 15 years |

lema like long duration fevers, long lasting and frequently recurring skin problems of • various types, eye problems, continual digestive tract problems, pain in joints and body ache, a persistent feeling of lethargy and general debility, are all two to three times higher in the proximate villages. The probability that such differences could be a coincidence (in other words without a 'causative' agent) in most cases is less than one in a thousand.

Detailed specific analysis of these general complaints reveals more. When general eye problems are examined, we find that while there is no difference at all in cases of conjunctivites, the incidence of cataract is almost double. Similarly, for skin problems, we found larger numbers of problems such as hyperkeratosis and hypopigmentation. A great surprise was finding four men with large keloids all over their body, none of whom had any history of injury and three of whom had worked at RAPS in the past. The largest differences were to be seen in solid tumours of various kinds. While there were 30 cases of these tumours, one of them as large as a football on the chest of a women and several were the size of tennis balls. There were only five such cases in the distant villages and none so large.

A detailed diagnoses by doctors of each complaint of each individual was a task beyond our capability. Wherever proper diagnoses was done, it provides very eloquent testimony. Nine cases of pterygium—an eye problem Associated with the growth of cornea implicating radiation (usually found in workers using welding, equipment)—were observed among children by the doctors. Since this was a condition of which (in the early stages) even the sufferers were unaware of, these would not be reported to the investigators as a complaint. While we can make no statements of statistical significance regarding pterygium, since our methodology was not refined enough to do so, this does make a case for a thorough examination by eye specialists of the incidence of this disease in the area around Rawatbhata.

Another aspect of this disease pattern is the greater susceptibility of the young in the near villages to various health problems. This is seen in a number of complaints across the board (see the average age of complainant in Table 9). We find that there are some symptoms for which there is no difference in the average age between the two areas, and others where the difference in the average ages between the two areas is as much as 12 years. Invariably we find the younger invalids to be living near the nuclear power plant. Since the variation in the ages is very great, we are not in a position to make statistically significant statements regarding age, but it is a remarkable trend.

We were not equipped to detect cancers. But we found four cancer patients in the proximate area, who had been diagnosed as such by hospitals in Kota and Udaipur and who were taking treatment. Amongst the 75 persons who had died during the last two years in this area we found that six who had done so from various kinds of cancers and whose relatives had papers of hospital admissions and treatment. In contrast we found just one person in the remote area to have papers regarding cancer treatment.

## A note on Statistical Significance

There are well established statistical procedures to compare some quantity in two different populations, like for example congenital deformities in far and near villages. Essentially, one is looking for the answer to the following question: what is the probability that the difference in the observations in both areas is purely due to chance? If the probability (p) is less than 5 per cent then statisticians accept that the difference in the two observations is not due to chance but is the result of some 'cause'. Thus when we say that p is less than 0.001 for the prevalence of congenital deformities in the populations of the far and near villages, what one is saying is that the chance that this difference could be purely a coincidence is less than one in a thousand.

**"Increasing radiation exposure accelerates the aging process. The wear and tear caused by radiation results in the gradual accumulation of mistakes in the body's homeostatic mechanisms."**

*Dr ROSALIVE Bertell*
*No Immediate Danger: Prognosis for a Radioactive Earth*

*April / May 1993*

## Deformity Pattern

| Deformities | Proximate Villages | Distant Villages |
|---|---|---|
| **total Population** | 50(44) | 14(14) |
| **Above 16 years** | 5(5) | **4(4)** |
| below **18 years** | **45(39)** | **10 (10)** |
| below **11 years** | 38 (33) | **6(6)** |
| **Deformity Pattern Soon In the Last Two years)** | | |
| LIVE B**ORN** | | |
| With Deformity | 16 | **3** |
| Without De-formity | 236 | **194** |
| **STILLSORN** | | |
| With Deformity | 4 | **0** |
| Without **De-formity** | 2 | **0** |

**A distinction needs to be, made between congenital deformities and deformities acquired later either through illness or accident. All the deformities, without exception, that were observed in both the areas were examined and classified by doctors.**

**There is no statistical difference in the number of acquired deformities in both areas. These deformities (see table 9) are due to various causes, like accidents (9 near, 7 far); blindness due to smallpox (4 : 2); Burger's disease (4 . 3); paralysis due to neuromuscular disease (3 : 1), and so on.**

**Deformities due to polio bear closer scrutiny. The total numbers are 24 in the proximate villages and 17 in the distant villages. These numbers in the total population of each area are not significantly different. The mean age of the polio victims in both the areas is similar. However, if we look at the age wise distribution, we find that there are larger number of young children in the proximate villages, who are polio victims.**

**Table 10 tabulates the prevalence of congenital malformations in the population of the two areas.'The prevalence is significantly higher ($p<0.0009$) for proximate villages over distant villages for the total population taken as a whole. However, if one compares deformities only in 'children, the differences in the two areas become more pronounced While the relative risk for deformities is 2.8 ($p<0.0009$) for the total population, it increases to 3.45 ($p<0$ 0005) for people leas than eighteen years of age (born after RAPS-1 started), and to 5.08 ($p<0.0002$) for children less than eleven, when the second unit commenced. It is also significantly higher amongst children in the proximate villages when compared to the adult population, even when account is made of the higher early mortality due to life-threatening congenital malformations. When we compare the number of deformities between children and adults of the proximate area itself, we find the p to be less than one in a million (0.0000001). liters Is no significant difference in congenital malformations amongst adults of the two areas or amongst adults and children of the distant villages.**

**Deformities of the musculo-skeletal system (such as amputed hands and toes, club foot, extra fingers and webbed feet and other limb deformities) were predominant (16 in proximate villages as compared to 5 in the distant area). Other major types observed were deformities of sense organs, deaf mutism, mental retardation, deformities of ganito-urinary system, central nervous system and the digestive system. No minor deformities (skin tags, heamangiomas, birthmarks, ear tags, tongue-ties, etc.) were recorded in either area. Two families (one each in both areas) have all siblings with serious congenital squints in both eyes. But for this singular instance, all the other deformities in the proximate area are not running in families. Although there are two instances of two deformities in the same household, they are both different deformities, and the parents in all cases do not have the deformity. In all the ~~ca~~ses of musculo-sksletel deformities in children in the proximate villages, the deformities are unilateral (one-sided). The significance of this is due to the fact that inherited (familial)**

**The figures in parenthesis are the number of people. There are five cases of multiple deformities all in proximate villages, four with two deformities each and one with three. The category 'below 18 years" includes the category "below 11 years". There is an almost three to one preponderance of males over females with deformites in both areas. 31 and 20 children born during the last two years respectively in proximate and distant villages have died (see Table 12)**

## Table 10: Deformity Pattern

deformities are usually bilat-
eral.

All the five cases of multiple deformities are children under the age of 18 in proximate villages. Four of them have two deformities each, while one has congenital deafness, a polycystic kidney and hydrocephalus together. ,

## Pregnancy Outcomes

As noted earlier in Table 6, the age of marriage, the age at which the new bride comes to live at her husband's house ('Gauna'), the age of the mother, at the birth of the first child, average number of pregnancies, the age of childbearing mothers averaged over all pregnancies etc. are all very similar in both areas. While the number of abortions, still-births, and congenital abnormalities amongst dead and surviving children (table 11) are all much higher in proximate villages, the average age of mothers at the time of these untoward pregnancy outcomes is similar (see Table 6). In our study we have considered abortion as termination of pregnancy after eight weeks of conception. That is after two consecutive periods have been missed. Congenital deformities amongst dead children were counted only in cases where the mothers were able to describe in detail the form of the deformity in the dead child. Most of these deformed children had either been stillborn or had died within a few hours of birth. They seem to be mainly cases of neural tube defects.

In the survey there were separate questions regarding births during the last two years. Since our survey depended on people's recall of events, the last two year's numbers are likely to be more reliable as compared to those of earlier years. During the two years previous to the survey, there were 20 babies born with some kind of deformity in the proximate area. In contrast, there were only three such babies in the distant area. Of the 20, four were still born while 16 were liveborn but nine of them had died by the time of the survey and there were seven children who were still alive.

| Time Period _____ | Proximate Villages | Distant Villages |
|---|---|---|
| Abortions | | |
| Within Last Two Years | 27 (9.4) | 5 (2.5) |
| Between 2 and 10 Years | 35 (4.6) | 15 (2.1) |
| Between 10 and 20 Years | 15 (3.0) | 9(2.3) |
| More than 20 Years | 3 (2.5) | 0 |
| Still-Births | | |
| Within Last Two Years | 6(2.1) | 0 |
| Between 2 and 10 Years | 20 (2.6) | 6 (0.8) |
| Between 10 and 20 Years | 13 (2.6) | 5 (1.3) |
| More than 20 Years | 5 (4.2) | 1 (14) |
| Bom Alive But Now Dead | | |
| Within Last Two Years | 31 (10.8) | 20 (9.9) |
| Between 2 and 10 Years | 111(14.7) | 118(16.6) |
| Between 10 and 20 Years | 83 (16.8) | 92 (23.2) |
| More than 20 Years | 30 (25.4) | 18 (24.3) |
| Living | | |
| Within Last Two Years | 221 (77.3) | 177 (87.6) |
| Between 2 and 10 Years | 589 (77.9) | 572 (80.5) |
| Between 10 and 20 Years | 383 (77.5) | 290 (73.2) |
| More than 20 Years | 80 (67.8) | 55 (74.3) |

The number in parenthesis are percentages of the particular outcome in relation to other outcomes within the same time frame. For example a, 9.4 percent of the pregnancies in proximate villages during the last two resulted in abortions, 2.1 percent in still births and the rest resulted in live born children. Of these, some, representing 10.8 percent of the deliveries have already expired while the other 77.3 percent still survive.

## Table 11: Pregnancy

Table 13 lists 10 deaths due to congenital abnormalities but' that includes one boy who had been born with deformity more than two years ago, but who had died within the last two years. In the distant villages, of the three children born

| Time Perlod | Proximate Villag | | |
|---|---|---|---|
| **Abortions** | | | |
| Within Last Two Years | 27 (9.4) | 111(14.7) | 118(16.6) |
| Between 2 and 10 Years | 35 (4.6) | 83 (16.8) | 92 (23.2) |
| Between 10 and 20 Years | 15 (3.0) | 30 (25.4) | 18 (24.3) |
| More than 20 Years | 3 (2.5) | | |
| **Still-Births** | | | |
| Within Last Two Years | 6(2.1) | 221 (77.3) | 177 (87.6) |
| Between 2 and 10 Years | 20 (2.6) | 589 (77.9) | 572 (80.5) |
| Between 10 and 20 Years | 13 (2.6) | 383 (77.5) | 290 (73.2) |
| More than 20 Years | 5 (4.2) | 80 (67.8) | 55 (74.3) |
| **Bom Alive But Now Dead** | | | |
| Within Last Two Years | 31 (10.8) | | |

**Living**

**The number in parenthesis are percentages of the particular outcome in relation to other outcomes within the same time frame. For example a, 9.4 percent of the pregnancies in proximate villages during the last two resulted in abortions, 2.1 percent in still births and the rest resulted in live born children. Of these, some, representing 10.8 percent of the deliveries have already expired while the other 77.3 percent still survive.**

deformity during the last two years, two were alive while one had died. We made a separate calculation for the mean age of mothers of deformed children born during the last two years. The average age of such mothers in proximate area was 27.6 years and it was 22.7 years in the distant villages. Four such mothers were more than 35 years of age (all less than 40) while pone was younger than 19. Of the three mothers in the distant villages, one was 16, another 22 and the third was 30. It is known that the chances of bearing a deformed baby are higher if the mother is either very young or very old. These numbers indicate that this cannot be an explanation for the observed differences in deformities amongst children.

Abortions and still births were also seen to be far higher in proximate villages during the last two years. It might be argued that these numbers are 'unverifiable'. But there is strong circumstancial evidence which reinforces this finding. There are significantly larger number of issue-less couples (couples who have been married for at least four years, have been trying to have children and have either never conceived (23 vs 13) or have not given birth to a live baby due to repeated abortions and stillbirths (13 vs 2) in the proximate area.

Age specific fertility rates and age specific marital fertility rates were calculated for both the areas based on pregnancy histories of women of reproductive age. These numbers are in good agreement with those from census data for the area. Although we made all efforts to contact each and *every* eligible woman, we did miss a few (nearly 16 percent in both areas) sines they were not available, being away from the area during the time of the survey.

| | | |
|---|---|---|
| Crude Birth Rate | 44.1 (34.3) | 38.7 (38.7) |
| Gross Fertility Rate | 193 | 179 |
| Age Specific Fertility Rata<br>Age Group | Proximate Villages | Distant Villages |
| 15 — 19 | 68(71) | 50(88) |
| 20 — 24 | 330(254) | 318 (262) |
| 25 — 29 | 347 (267) | 359 (252) |
| 30 — 34 | 263(212) | 171(177) |
| 35 — 39 | 26 (62) | 123(119) |
| 40 — 44 | 57(21) | 26 (62) |
| 45 — 49 | 0 | 0 |

1 The numbers in parenthesis are fertility rates for Chittorgarh
1
1 and Mandsaur districts in Rajasthan and Madhya Pradesh
1
1 The gross fertility rate has been calculated per thousand
1
1 women of reproductive age.
1

Table 12: Fertility Indicators

**Untoward pregnancy outcomes are significantly greater near the nuclear power plant. The number of people complaining of sterility is greater. Abortions and still births are far larger. The number of babies who die within a few hours of birth is much larger. More congenitally deformed babies are born. These huge differences cannot be explained away by pointing to unsanitary living conditions. Neither can these differences be attributed to differences in the ages of child-bearing mothers, which are similar.**

## Mortality

***It may be he shall take my hand***
***And lead me to his dark land***
***Close my eyes and quench my breath,***
***For I have a rendezvous with death.***

**76 persons died in the proximate area during the two years previous to the survey. The equivalent number in the case of the distant villages was 59. Since the population of the proximate area was 2860 as compared to 2544 in the distant Area, these numbers at first sight do not appear to be alarming. But the moment we do a break up of these numbers in terms of causes of death, and also in terms of age at death, these numbers tell a very different and a frightening tale. The difference in the average age of the deceased in the two areas is 11 years. People are dying younger in the proximate area.**

**Although these differences in the mean ages of people dying are dramatic, since the variation is very large, they are not statistically significant. To demonstrate statistical significance in mortality numbers would need a much larger sample size. But the numbers do demonstrate a trend, and it would not be difficult for any agency like the census bureau to conduct a larger survey and compare the results with those for other comparable parts of rural Rajas than and Madhya Pradesh.**

**Let us first consider neonatal mortality. That is those newborn babies who died within first four weeks of birth. There were 16 such babies in the proximate area and eight in the distant area. But we find a very high proportion (7 out of 16) of early neonatal deaths in the proximate villages to have taken place within one day of birth.**

Cause s of Death in Children **(Aged <5 Years)**

| **Cause • of Death** | **Proximate Villages** | **Distant Villages** |
|---|---|---|
| **Fevers** | 3 | 7 |
| Diarrhoea | 6 | **3** |
| Tetanus | 1 | **6** |
| Respiratory Infection | 1 | **3** |
| Measles | 1 | **0** |
| Polio | 1 | **1** |
| Congenital Defects | 10 | **1** |
| Small Baby | 10 | **1** |
| Unknown Causes | 3 | **1** |

Causes of Death in Adults **(Aged** > Five Years)

| | | |
|---|---|---|
| Fever | 11 | **9** |
| Respiratory Problems | 5 | **6** |
| Diarrhoea | 5 | **6** |
| Old Age | 8 | **14** |
| Pain Abdomen | 2 | **1** |
| Paralysis | 2 | **2** |
| Accidents | 1 | **2** |
| Perinatal **Deaths** | 2 | **0** |
| Cancers | 6 | **2** |
| Unknown Causes | 0 | **3** |

Table 13: Causes of Death

| | **Proximate Villages** | **Distant Vlllages** |
|---|---|---|
| **Stillbirths** 6 (1.9) | | **0 (1.5)** |
| **One Day Deaths** 7 | | **1** |
| **Early Neonatal Deaths** 13 (8.2) | | **5 (8.5)** |
| **Infant Mortality 32 (28.2)** | | **19** (22.6) |

**The numbers without parentheses are the actual observations. The number in parentheses are those expected on the basis of census data for Rajasthan and Madhya Pradesh.**

**Table 14: Deaths Amongst Infants During the Last Two Years**

There was just one such case in the distant villages. If we exclude these one day deaths, then there is hardly any (half a day's difference) between the average ages at death, of the neonates.

An examination of the causes of death amongst children less than five (Table 13), shows that infections, fevers, tetanus, are the predominant causes in the distant area, but that is not the case in the proximate area, where, congenital deformities, small size of the baby and diarroea are more common.

We find a contrast in the causes of death in adults as well. The number of patients who succumbed to cancer is far too high in the proximate area. We have only counted those in this category, whose relatives were able to show us hospital papers which certified cancer.

| Age Group | Proximate Villages | Distant Villages |
|---|---|---|
| 0—4 years | 47.4 | 36. 1 |
| | 5.5 | 3.5 |
| 15—24 years | 3.5 | 0 |
| 25—34 years | 2.4 | 4.2 |
| 35—44 years | 8.5 | 2.0 |
| 45—54 years | 7.3 | 3.0 |
| More than 55 years | 23.3 | 33.0 |

**Table 15: Age Specific Death Rates**

Another difference that we observed was that two cases of maternal mortality were observed in the proximate area. None was seen in the distant villages.

The numbers in parenthesis in Table 12 were calculated from the census data for Madhya Pradesh and Rajas than for 1987. Analysing the census data over the last two decades, we find a steady decline in all mortality indicators, including the stillbirth rate. Our observation of zero stillbirths during the last two years in the distant villages is within the range of statistical fluctuation. The observation of six stillbirths in proximate villages is significantly higher.

# Limitations of the Survey

The survey does suffer from a number of limitations which should be kept in mind while evaluating the results. These limitations need to be overcome in any future research project.

As discussed in the methodology, we started with a hypothesis that the wind especially during the monsoons, was the main carrier of radioactive effluents from the plant to the surrounding population. The reason for favouring this hypothesis was that during the monsoon months the wind velocity is generally high and so is the precipitation. As a result, the "routine emissions'[9] from the plant are likely to get carried to the nearby villages over the hills and then get precipitated there. Once these radionuclides get deposited in the soil they are likely to get into the food chain and since a lot of the food produced in this area is also consumed locally these radionuclides would have an adverse effect on the health of the local residents. However, during the survey we found that there were many other equally likely pathways which could perform the task of transporting radioactive waste from the plant premises to the local population. One important alternative pathway for example is due to the fact that a lot of people in the nearby villages work as casual labourers in the plant premises and hence are getting directly exposed. Since the villages we have chosen near the plant all lie in a cluster in the north east direction, they do not constitute a representative random sample of all the people living in the ten kilometre vicinity of the plant. There have been a number of anecdotal reports regarding deformities and tumours and diagnosed cases of cancer amongst the people in these other villages as well as the township of Rawatbhata. In fact, we too have come across a number of such cases in villages other than the survey villages. Thus, though this survey does unambiguously indicate something drastically wrong in the area around north- east of Rawatbhata, a more complete study taking a statistically proper sample of all the population around the plant still needs to be done. In fact, the possibility of different pathways for radioactive pollution to reach the local population makes us suspect that what we have seen in the survey is just the tip of the iceberg and a more comprehensive survey would detect far larger number of sick and deformed people especially children who would need special care from the society at large.

**A major flaw in our methodology was that the questions we asked the respondents regarding employment, were related to their present status of work. There were no questions regarding past employment. Thus, our survey is not able to distinguish between those who have never worked in the RAPS complex and those who have worked there in the past but were not working at the site at the time of the survey. Since casual employment is strongly dependent on a lot of factors including the seasonal need for agricultural labour, and the status of the plant operation, the actual number of people who do work at the plant can vary greatly from time to time. Thus our finding that over 26% of households have at least one member working in the plant complex, is just a 'reading[1] and not an annual average. There could be many more or less number of people who might have been going to do work in RAPS at different times. There were also no questions to distinguish between those whose work would take them inside the plant proper and regarding the kind of work they did there, and others whose work might not have involved going inside the plant but was confined to the premises of the plant This is an especially serious shortcoming since we are not able to say anything about the employment of parents of congenitally deformed children at the time the children were born.**

**We stated before that the Rawatbhata area is devoid of other industries and vehicular traffic so that there are no confounding factors. However, this statemeat needs to be qualified. There is one other large plant in the area and that is the Heavy Water Plant run by the Department of Atomic Energy. This plant uses a process which involves the use of large quantities of hydrogen sulfide gas and sulphur dioxide gas. There have been leaks of these gases to the environment in previous years, and during the survey many people even as far away as ten kilometres from the plant told us about the strong smell of rotten eggs which made life almost impossible at times. The synergistic effects of radiation and chemical pollutants are as yet not very well understood but there is no doubt that this can be an additional factor in the poor condition of the health in proximate villages.**

**Many people work as casual labourers in the heavy water plant as well. The heavy water plant acts not only as a production unit of fresh heavy water but also as a unit which refreshes degraded used heavy water. This latter kind of heavy water is radioactive and the casual workers do receive an occupational dose. This dose consists of not only external radiation but also more importantly workers inhale radioactive tritium and hence receive an internal dose.**

***Casual workers provide a true cross section of the weaker sections of our society. Studies on them would be of great relevance to a majority of the population.***

**Studies of radiation and nuclear industry workers all over the world have been bedevilled due to what has been called "the healthy worker effect". This pertains to the fact that while the carcinogenic effect of radiation is well established in a very large number of studies, radiation workers by and large show less number of cancers than the average population at large. As has been pointed out by Dr Alice Stewart amongst others, this dearth is due to the fact that nuclear industry workers are amongst the well to do section of the society, and they are chosen for the job after medical examinations which would eliminate weaker subjects. The casual workers on the other hand do provide a real and representative cross section of the weaker sections of our society and therefore results of studies undertaken on them would be of far greater relevance to a majority of the population.**

**A major deficiency of the study is the absence of any observation regarding radiation levels. Therefore, it is not possible for us to make a clear claim that radiation from RAPP is the cause of the poor health and the high number of deformities seen in the neighbourhood. What we can say from this epidemiological survey is that the health status of the people is unusually bad and this deterioration cannot be facilely attributed to poverty ignorance or unhygenic living conditions. Radiation can be a likely cause, and the pattern of disease and deformity does show similarity with other patterns seen elsewhere in the world where too radiation has been involved.**

**Another deficiency of this study is the absence of laboratory backup. Nowadays, with the advance of cytological techniques it is possible to undertake analysis of chromosomal aberrations of people and do what is called biological dosimetry". By this procedure it is conceivable to make a very food estimate of the radiation dose received by the subject in the past. This needs to be done and the results should be compared with the estimate* of the radiation dose produced by the environmental survey laboratories of the Department of Atomic Energy. This procedure can supplement radiation measurements and both together can be a very good indication of the damage being caused by radiation from RAPS.**

***1993***

# Discussion

***During the three years after the first newt reports regarding the puzzling health condition of the people in the vicinity of RAPS appeared, there have been a number of denials and explanations offered by the nuclear establishment and the government authorities. A previous issue of Anumukti (Vol.6 No.2), in the article entitled "Lies, Damned Lies and Nucleocratic Explanations", we discussed these explanations at length. In this section, we shall discuss the results presented earlier and speculate on the various factors that might be contributory causes to the observed health effects. In the course of this discussion we will also comment on some of the various official explanations.***

## Disease Pattern

### Reality' of the Health Effects

The survey clearly and unambiguously indicates that the health status of the people living in the proximate area is definitely worse than that of people living in the far-off villages. This conclusion is so obvious that normally we would not mention it separately. We are doing so because official spokesmen have tried to suggest that -people's health is not being affected.

*"These reports are uninformed and in some cases part of a campaign to stop India from pureuing its nuclear research and power generation."*

Atomic Energy Commotion Chariman
Dr. P. K. Iyengar *Hindustan* Times
179 1991

*"These reports are based on conjectures and have no basis whatsoever. "*

Or D.V.Goprnath, Director. Health.
Safety and Environment Group at
Bhobno Atomic Reseorch Centre
*Hindustan Times* 179 1991

*"The stories regarding radiation malaffects on the population near RAPS are totally imaginary and facts being mentioned do not have even a distant relation* to reality. Some highly placed RAPS officials maintain that villagers are "trying to blackmail RAPS". "These people think that through such adverse propaganda they can force RAPS to provide them with more employment and free medical facilities. "*

Pothik Guho
reporting in *The* refegrapn

**It is a strange mentality which considers popular demands for a share in the fruits' of development as an effort at blackmail . However, let us pass over this point. The results of the survey clearly show that the authorities have bean far too quick in dismissing earlier reports. They have made unsupported assertions without checking the facts. There can be no dispute regard -ing the existence of adverse health effects in the proximate region.**

## Radiation Related?

**Two separata questions form the crux of the problem. Can a hypothesis of radiation as a causative factor account for the type and the amount of differences seen in the total pattern of disease and deformities? The other question is, whether there is any possible pathway for radiation and radioactive nuclides produced in RAPS to reach the nearby villagers?**

**The health implications of Hiroshima studies, according to nucleocrate are an increase in leukaemia and in certain types of cancers. This, according to them is the only radiation related health effect at low levels.**

**We have previously, ("Lies, Damned Lies and Nucleocratic Explanations in *Anumukti* Vol.5 No.2) discussed the falsity of this claim. Let us consider the** implications of starting with such a mind-set.

Cancers and leukaemia though they do occur 'naturally', are extremely rare events. To And excess cancers, over and above their natural occurrence, would require health monitoring of large papulations. Since nuclear power plants are deliberately sited in sparsely populated area, the monitoring has to be carried out over a wide area. It becomes extremely difficult to find another such sparsely populated area with similar characteristics to act as 'control' and to separate out effects due to other environmental pollutants and arrive at any meaningful result. Therefore, an acceptance of cancer and leukaemia as the only radiation related health effect, makes it very difficult to find any nuclear plant, however dirty and polluting, to be the 'cause' of health problems in a neighbouring population.

*"Cancer is nothing new to this region. In recent times cancer incidence has shown an increase all over, even in regions far away from nuclear power plants."*

Dleep Shotta - on engineer ot RAPS in
*Janonayak.* I4,10,91

It is no wonder that with such a mind-set, expert committees appointed by the Government of Rajasthan, failed to find any evidence of "radiation-related" health effects in the villages around Rawatbhata by looking at a few people in Jharjhani, as reported by the honourable Minister of State for Science and

Technology, Shri P. R. Kumaramangalam, to the Parliament on July 29, 1992.

Moat objectionable feature of the 'survey' conducted by these expert committees was the fact that they have not bothered to publish the findings but have instead submitted a confidential report to the government. While doing this may be acceptable bureaucratic procedure, it is totally contrary to the spirit of scientific enquiry.

Shri R. Ramachandran is the science editor of *The Economic Times.* In the article entitled, "Who is Right About RAPS", *(Economic Times* 27.10.1991) he has articulated the pro nuclear position regarding RAPS. Since this article has been reprinted in full in *Nuclear India,* one can presume that the views expressed have official approval.

*'There is absolutely no evidence of radiation, in any dose, leading to polio-like deformities."*

This statement by Shri Ramachandran insinuates two things. One, that most of the deformities seen in the vicinity of RAPS are caused by polio; second, that-whatever is seen could not be due to RAPS since radiation does not cause polio. As can be seen from Table 9 and table 10 polio victims are not a preponderant majority amongst the deformed in either area. The prevalence of polio is not significantly different in both areas while that of congenital deformities certainly is. Radiation may not be the 'cause' of polio, but it is well known that radiation adversely affects the immune system and thus reduces the power of the body to combat disease. This phenomena of reduced immune response after radiation exposure has been seen most dramatically in Kazakhstan and in areas of Belaruss adjoining Chernobyl, where people especially children have become victims to a whole host of diseases. A new term —"atomic

***The general public has been given the impress' ion that exposure to radiation involves a slight risk of dying of cancer and that one's chances of escaping this are better than the chances of escaping an automobile accident, Theprobabilities of early occurrence of heart disease, diabetes mellitus, arthritis, asthma or severe allergies - all resulting in a prolonged state of ill health - are never mentioned. Most people are unaware of the fact that ionising radiation can cause spontaneous abortions, stillbirths, infant deaths, asthmas, severe allergies, depressed immune systems (with greater risk of bacterial and viral infections), leukaemia, - solid tumours, birth defects, or mental and physical retardation in children.***

***Dr Rosalie Bertell***
***No Immediate Danger: Prognosis for a Radioactive Earth***

**AIDS" has been coined to describe it.**

**Although the prevalence of polio as well as the mean age of polio victims in both areas is similar (0.8% of the population in the proximate area verses 0.7% in the distant area) and 21 years in either case respectively, there are some differences. If we consider only children (<18 years), we find that the number of victims in proximate area (16), to be double that in the distant area (eight). Since there are a lot of other factors like the effectiveness of the polio immunisation programme involved in the incidence of the disease, it is not possible to make any definitive statement regarding it, based on these numbers.**

## Radiation Pathway

**The argument of the nuclear lobby has focussed on the improbability of radiation in appreciable quantities reaching the people. The argument has been couched in the form of a counter-question. If the operation of RAPS is responsible for the health effects seen in the vicinity, then why have, these effects not been seen amongst RAPS' employees?**

***"If the main mischief maker is RAPS, then why are the children of t/ie plant workers not deformed? I (Chief Superintendent of RAPS, Dr Ramanan) have worked at the Madras Atomic Power Plant for 14 years and at Tarapur for nine years, before I came here a few months ago. Logically I am receiving much more radiation sitting on my chair here than a villager at Jharjhani or Tamlav, but am 1 affected?* "3**

***"The reported health problems in a few villages around RAPS have not been evident beyond natural incidence in the plant workers or their families living in the adjacent plant township. It was to be noted that the limits for radiation exposure for occupational workers was 60 times that recommended for the public"***

**Mr. S.L. Kotl, Managing Director, Nuclear Power Corporation**
**Finonocial *£xpress* 21.11. 1 991**

**There are a number of hidden assumptions in a statement like that of Dr. Ramanan'e, some of these assumDtions are not al-**

ways valid; some are outright false. But it is a statement that is often repeated by many in the nuclear establishment and it seems to impress the gullible members of the public, so let us consider it.

The response of a biological system to radiation is variable. Different people receiving the same dose, may show different effects. Apart from acute radiation disease (observed at extremely high doses in, for example, the firefighters at Chernobyl), there is no specific 'marked' disease caused by radiation. Low level radiation does not produce a low level radiation disease[9]. One of the things low level radiation does is that it makes people more prone to a whole host of 'naturally' occur* ring diseases. It increases the risk of ill health in the affected population. If a particular individual develops a specific disease that fact is not considered proof that the disease was 'due' to radiation; similarly, the fact that a particular individual hasn't developed any disease does not mean that radiation at that or less than that level is harmless. Scientists working in the field are well aware of the stochastic nature of radiation effects and yet nucleocrats will miss no opportunity to misinforfa the public by making such misleading comments to interviewers from mass circulation media.

The other assumption in the quotation above is that the regular RAPS workers are receiving larger radia'tion doses than the people living in the nearby surveyed villages. Whether this assumption is true or not depends on a number of factors. Regular workers are not a monolithic block of people all going inside the radiation fields in the reactor complex everyday. Workers consist of all kinds: operators, mechanics, security men, typists, public relation officers, station superintendents, etc. Some do receive radiation doses, some

*/ used to work in Waste Management.* Once, *I received a dose of 2,200 mrem in half an hour. Others have been laid off after getting a dose of 800—1,100 mrem. Most workers get this much dose in six to ten days of work. One needs to work for just half an hour to one hour every day. You receive more exposure during shut-downs. The work involves moving material. Machines are used for heavy loads, but if the load can be lifted by one or two persons, then machines are not used. My lungs have become bad. I don 't smoke. I have gone to many different hospitals for treatment. They treat you for T.B. After a few days, the doctor tell you to stop taking the drugs. Then, they restart the treatment all over again. I have developed these burn-like red marks (keloids) all over my body. One of my mates in the plant, suffers from exactly the same problem. 1 have a seven year old son. He was born with a sternal deformity. Ever since birth his rectum comes out when he shits (rectal prolapse). Despite knowing the dangers of working in the plant, people go there because they get better wages. If I have to starve, I will starve, but I will not work at RAPS.*

**Manohar Singh**
**local ledent**

don't. Similarly, the category "villagers" does not consist only of people who have never seen the inside of the nuclear power plant. In fact there are a few regular employees of the plant (storekeepers, drivers and such like), who do stay in the survey area. Besides these 'lucky' few, there are a large number who are casual labourers, many of who go to work in the reactor complex every day.

It is unfortunate but true that in India largely illiterate, untrained, poorly paid (in comparative terms) casual labourers, have to do some of the most dangerous and dirty jobs. This is not unique to nuclear industry. This applies to a lot of other industrial enterprises as well. These casual worker* do not get anv advantages like iob security, medical facilities, special schooling facilities for children, etc., that are eiyoyed by regular nuclear workers. All, these poor people get is a better daily wage than is possible doing an unskilled job outside. Nonetheless, as far as their radioactive dose limits are concerned, they are considered nuclear workers. During the survey we came across a number of casual worker who told us that they had received doses of 2,200 mrem within a few hours at a time; then they had been laid off. None of the casual workers who talked to us said that their urine had been examined after work in the radiation field for internal (tritium) exposure. Even the regular workers said that urine examination was not n regular feature after work in the radiation areas. Some had

undergone medical checkups once a year during which their urine had been examined. We suspect that the amount of internal dose to any category of workers is not known very accurately by anybody. Casual workers also mentioned to us that often they were not even monitored for external radiation while working in the radiation field. Their Thermo Luminescence Dosimeter (TLD) batches are removed beforehand and kept by the contrac tor for 'safe custody'. Therefore, Dr Ramanan's assertion that he or other regular workers get a greater dose than a nearby Villager[1] is not universally true. Only a proper dosimetry of all the workers, regular and casual, working in the plant premises and meticulous record maintenance can decide this question.

The case with the workers' health records is similar. It is a fact that RAPS authorities take no responsibility at all for the health of their daily 'casual' workers. For health monitoring purposes, such workers are considered members of **the** general public, and hence no records of any kind are kept. On the other hand, when the question is one of receiving radiation doses, these workers are considered as nuclear workers and can receive radiation doses up to fifty times the 'permissible limit' of 100 millirems per year for the general population. Although the International Council for Radiological Protection had recommended more than two years ago to reduce the permitted dose to nuclear workers from 5,000 millirems to 2,000 millirems per year, this recommendation has still not beerenforced in India.

The health records of the regular workers, if maintained are not open to outtside scrutiny. One wonders whether any long term health monitoring of the families of regular workers is ever done. The assertion that regular workers or their families living in various colonies of RAPS at Rawatbhata, "do not show any effects beyond natural incidence", is totally unsupported. The fact is nobody knows whether they do or they don't since no scientific survey has been done to establish the truth. It needs to be emphasised that such a survey would have to be scientific, and would have to compare like with like, not the well fed, well-cared for nuclear employees with the general population. Most importantly, all the results of such a survey should be published and be open for possible criti-

*"I have myself seen—and reported in 1978, without being contradicted—that employees of the RAPS would work on maintenance jobs in the reactor building where the le~velg of concentration of tritium exceed 300 times the permissible amount."*

Praful Bidwal

cism of the methodology. During our stay in Rawatbhata, we gathered enough anecdotal evidence to suggest that such a survey would indeed be worthwhile. It would be of immense benefit to the nuclear workers themselves, since they would get a clearer idea of the kind of price they have paid for their comfortable lifestyle working in this 'high-tech' industry.

Geography may also be a factor responsible for the health differences, if any, between people living in Rawatbhata township and those living in the villages of the survey area. There are different pathways for radiological contamination in the region. The Colonies of Rawatbhata township lie some four to eight km north of the reactors. The survey villages are the same distance north-east of the plant. The river Chambal flows north* wards. It is likely that while routine releases to air from the plant would be a greater concern in the villages, since the wind direction during the monsoons is towards the north-east, the releases to water would affect Rawatbhata mere. Some nucleocrats have publicly taken the totally ridiculous position that there is no possible pathway for radiation to reach the public, since there are no releases at all. In fact according to Dr K.S. Parthasarathy, the secretary of the Atomic Energy Regulatory Board:

*"None of the two hundred and fifty shutdowns of the reactors has caused any radiation exposure to the public. Leakages do happen as in any industrial plant. Every drop of heavy water is collected. Heavy water costs several thousand Rupees a kilogram. All leaks are contained ."*

This is so preposterous a statement that it takes one's breath away through sheer brazenness. The fact that the person who made it is a senior functionary of the Atomic Energy Regulatory Board makes one shudder. Suffice it is to add that in fact the amount of heavy water lost despite all attempts at recovery, runs to more than 26 tonnes every year, according to the Prasad Committee's report. During reactor operation heavy water in the reactor gets 'tritiated'. The deutrons (the heavier non-radioactive form of hydrogen) absorbs neutrons and some of it gets converted to tritium, which is a radioactive form of hydrogen. Over a period of time, this radioactivity accumulates and if there is any release of tritiated water vapour to air or to water this radioactivity finds its way into the environment As can be seen from Table 1, there is a substantial routine release of radioactivity in the form of tritium and argon-41 to the environment from the plant. Besides these "routine releases"

to air, there are releases of radioactivity to water. The disposal of "low- level" solid nuclear wastes in the vicinity, also can (if one is not careful) contribute to the contamination of drinking water supplies. Even while admitting the fact that there is release of radioactivity into the environment, nucleocrats have claimed that the radiation dose received by the most exposed people is negligible compared to the natural background radioactivity. They also claim that this dose has not shown an increase over the years.

*"Environmental Survey Laboratory has been in operation over the past 19 years. Radiation surveys as well as collection and qnalysis of 2,500 samples a year of water, soil, food, cur and various other products, has been carried out in an area of about 30 km radius around the plant. The average annual radiation dose computed on the basis of actual air and water route releases over the past 17 years has been less than 5.5 mrem per annum, except 1988 and 1990, when it was about 8 and 12 mrem per annum respectively."*

Mr. S L Kotl. Managing Director. Nuclear Power Corporation *Finanacial Express2)* 11 1991

'T/ie *totat radioactivity exposure from ail routes, external as well as internal by way of food etc., received by an individual in the RAPS environment has been around 1-1.7. mrem per year. The total background radiation in the area is around 81 mrem per year and the exposure limit for the general public set by international regulaioiy bodies is 100 mrem per year."*

Or D.V.Gopinofh. Director, Health. 'Safety and Environment Group at Bhabha Atomic Research Centre *Hindustan Times* 17 9 1991

The numbers in these two quotations, both from high ranking nicleocrats, vary so much that one doesn't know which figure to believe. These two statements may be dismissed as "being news releases and not meant for **a scientific audience. But the same confusion holds true for 'scientific[1] publications as can be seen from Table 1 for tritium releases and the tritium measurements in air. The numbers just do not tally. The validity of the measurements carried out by the Environmental Survey Laboratory is thereby called into question.**

***let* us see now if the observed disease pattern could be due to other environmental factors.**

## Malnutrition

**The questions regarding diet were asked to every fifth house-. hold. These households were randomly selected. The results show that the nutritional status of both the areas is exactly the same. The average caloric intake shows no difference and the variation in both places is similar. The average caloric intake in both places is the same as the caloric intake in an average Indian diet. The fact that the average caloric intake in both places is similar and the value is alike to that obtained by other surveys shows two things. First, it shows that our methodology is not erroneous and secondly, it rules out the possibility that malnutrition could be the cause of the health effects. Some cases of undernourishment (especially amongst children) were seen, but they were seen in both areas. It has been suggested that severe malnourishment could be the cause of higher abortion and still birth rates. The results of the survey do not support this theory.**

## Other Industrial Pollutants

**There is no large industry anywhere in the vicinity except the atomic power plant and the heavy water plant. Both are run by the Department of Atomic Energy. In the distant region there is no large industry of any kind at all. There is no a priori reason to expect other (that is non atomic energy related) industrial pollutants to be the cause of the observed health effects.**

## Pesticides and Fertilizers

**Large scale use of pesticides and fertilizers can be a cause of genetic deformities. However, the survey found that irrigated land and consequently, the use of pesticides and fertilizers, was greater in the distant villages, than in the villages near RAPS. Thus, any affect on this account would be in the opposite direction to what is observed.**

## Smoking

**There were no questions in the survey questionnaire regarding smoking habits. However, if differences in smoking habits had been a significant factor, we would expect to see differences in breathing related problems, such as bronchitis, asthma, emphysema, lung cancer and the like. We did not see any such difference between the two areas.**

## Bacterial Contamination of the Water Supplies

***"If the poor health conditions of the people reflects anything it is the dismal living, particularly sanitary conditions and near absence of any health care system. For example, the coliform count—as collected by the state government authoritie-of the water that is generally consumed by the village population is in thousands and tens of thousands when potable water should have near zero count. The bacteria levels are also very high. These can be the cause of general poor health conditions making them highly vulnerable to a whole lot of infectious and other diseases."***

**R Romachondion, ' Who is Right About RAPS", Economic Times 27 10 1991**

**Table: 16**
**(Central Water Commission)**

| Site | Coli-form /100ml | Bac-teria/ml |
|---|---|---|
| RAPS | 9 | 2 |
| Tarm lav well | >2400 | 150 |
| Tamlav pond | >24,000 | 320 |
| Deeppura well | 240 | 20 |
| •Jharjhani well 1 | 1100 | 40 |
| Jharjhani well 2 | 240 | 95 |
| Jharjhani well 3 | >2400 | 170 |
| Pump | 23 | 10 |

The pattern of diseases that we observe does not support the hypothesis that water borne infections are the main cause of the health problems. If this hypothesis were true, one would expect to see not only differences in long term chronic cases of gastrointestinal tract, which we do observe; but also differences in acute infections like diarrhea, short duration fevers, conjunctivitis, urinary infections etc. We do not observe any such differences. Chronic eye problems are much higher in the nearby villages. Problems like cataract, pterygium, etc. are unrelated to bacterial contamination of water and we would not expect to see higher levels of these in nearby villages as observed, if water-borne infections were the only cause. Similar is the case with solid tumours; they are not known to be caused by bacterial infection. We observe a very large difference in solid tumours in nearby villages. The same is true with congenital deformities and cancers. In the latter case, our procedure was not capable of detecting cancer cases; we only recorded those who had been diagnosed as cancer patients by hospitals and who had the papers. Although there was a large difference in the two areas in the number of diagnosed cancer cases, it may be argued that the villagers suffering from cancer in the distant villages have not got themselves diagnosed. This is unlikely, since we found that residents of both the areas were going to doctors and hospitals for chronic ailments; in fact the villagers in the distant area found it easier to get to Rampura and 'proper' medical attention than those in the proximate villages.

More than 38 percent of the population of the proximate villages get their drinking water either from the tap (see Table 7) or from hand-pumps. Construction work is presently going on in the Anushakti complex on RAPP-3 and RAPP-4. The skilled migrant construction workers who live in a colony near Tamlav demanded a better source of drinking water than those available. It was due to these reasons that a tap water supplies were provided since last two years. These supplies are comparatively uncontaminated. If bacterial contamination were the main cause of the observed disease pattern, one would expect a far smaller number of health related problems in those households using these /supplies as compared to other households in the same villages using far more contaminated sources of water. We do not find any such correlation.

The general state of sanitation in both the areas is similar. This is a somewhat subjective assessment, but there is some tangible evidence in support of this conclusion. If we look at the pattern of infant mortality in the last two years, we find that there is a large difference in the number of still-births and one day neonatal deaths. There is no difference in the numbers of children who have survived the first day but who died within the first ten days. There can be many factors responsible for the difference in one day mortality, including the quality of obstretic care and genetic factors. Later mortality is more dependent on environmental factors like cleanliness and possibility of infections like tetanus etc. The lack of differences in these mortality rates lends weight to our subjective assessment that both areas were equally clean/dirty.

The high incidence of chronic gastro-intestinal tract infections that we observe in nearby villages, could of course be possibly due to the unsanitary condition of drinking water. This may also be a factor in the unusually high skin problems. One needs to add a caveat that a detailed breakup of different skin problems would not totally support this contention since we observed much higher numbers of people suffering from hyperkeratosis and hypopigmentation in proximate villages as compared to the distant villages. Water borne infections are an unlikely cause of these problems. Similarly, we found four men in the proximate area whose whole bodies were covered with large keloids. Keloids are not unusual in case of injury or puncture of the skin. Yet, all the four gave no history of iryury. They maintained that their condition had started as a small (pea sized) lesion and had grown to its present gigantic size. There were no such cases in the distant villages and this condition is again unlikely to have been caused by water borne infections. Since we do not have readings of the bacterial and coliform counts in drinking water in the distant villages, it is not possible for us to make any categorical statement regarding the role of drinking water in the pattern of disease. In fact, for all one knows the water quality in the far off villages may be equally bad, and the Rawatbhata readings are just the 'normal' for rural parts of central India. One finds that civil health authorities have known about the 'undrinkability' of water supplies in the proximate area for years, but have remained unmoved. Is bacterial contamination of water as unsolvable a problem as that of the disposal of nuclear waste?

# Congenital Deformities

Let us again start here with the official position

*"On an average ten percent of all new born children will have some defects or the other. They include cleft palate and additional fingers. The birth defects can be seen in any village."*

*Dr K* S Parthasarathy Secfetory
Atomic Energy Regulatory Board
*Times of India* 13 9 1993

What constitutes a birth 'defect? When Dr Parthasarathy talks of birth defects he might be including very minor conditions like skin tags, birth marks, etc. These minor conditions have not been included in our survey. The number of deformities detected would also depend on the skill and the instruments used for detection. Thus, X-rays and sonography techniques would detect some occult internal organ deformities that may not be apparent to the naked eye. It should be noted that the ten percent figure quoted by Dr Parthasarathy is much too high . and not supported by any study of congenital deformities done in India.

Unfortunately, there is a dearth of studies on the prevalence of congenital malformations in rural populations in India. Available data (see for instance references given in Dr I C Verma's authoritative book "Genetic Disorders in India"), are mainly concerned with incidence in hospital births in urban settings in which all births are examined by doctors and which also include autopsies of stillbirths and dead children in some cases. In a prevalence study like ours, the detection of congenital malformations is likely to be much less, since the chances of survival of individuals with life-threatening malformations are **slim and hence they would not be observed. It is known that 70% of deaths due to congenital malformations occur during the first year of birth. Also hidden internal organ malformations are likely to be missed in our procedure.**

**The only large prevalence study of the general population in India was carried out by the Anthropological Survey of India. This survey was conducted in 96 locations spread over 14 states and covered 47,974 individuals. The frequency of major and minor defects was 9.8 per 1,000 though considerable regional variation was observed. Unfortunately, despite all our efforts, we have not been able to receive a copy of this study and have had to rely on the references to it in Dr I.C. Verma's book. Although we are not able to make detailed comparisons regarding prevalence of deformities in different age groups, the percentage of deformities that we find in the distant villages is well within the range of this study, while those in the proximate villages are significantly higher This study also found that in the general population there was a marked preponderance of musculoskeletal deformities, which we too observed.**

***Last year my baby died. He was one year old. He had a big swelling between his buttocks. He was born like that. He never learnt to sit. We took him to many doctors in different places. A lot of money was spent but to no avail. He died.***

**Sojano**
**locolResdent**

**Hospital studies from various regions report a very wide variation (ranging from 37.9 per 1000 to 2.5 per 1000) in the incidence at birth of deformities. The last two year's births in our study show that the deformities at birth in the distant villages (15.2 per 1000) fall well within the above range, whereas those in the proximate villages (77.5 per 1000) are much higher. Deformity studies in the state of Rajasthan (which also include stillbirths) have reported an incidence ranging from 17.3 to 21.3 per 1000. They have reported a high incidence of neural tube defects which were responsible for considerable stillbirths and neonatal deaths. It seems likely from the description given by mothers and midwives that a good number of deformities seen in stillbirths and in babies who died soon after birth in the proximate villages could have been due to neural tube defects.**

**Reports from the Pickering nuclear power station in Canada (see *Anumukti* Vol.5 No.2), indicate significant increases in the incidence of various birth defects. As can be seen from Table 1 routine emissions from RAPS are on a larger scale than those from Pickering. The recorded occupational dose to workers is also much higher at RAPS. A point which needs to be considered in this connection, concerns the dietary and hygienic habits of the local population as compared to that in Canada. If there is radioactive contamination of the land and water sources due to routine emissions, the effects are likely to get accentuated in Indian conditions where people eat far more locally grown food than their counterparts in Canada. Similarly, our habits of defecating in the fields are likely to help in the recirculation of radioactive contaminants.**

# Early Deaths

**Scientists at the University of Bremen in Germany noticed in 1986 that one-day mortality in newborn babies, during the months following the Chernobyl registered a sudden rise in those areas of the country which had been most effected by the radioactive fall-out due to the accident Northern parts of Germany which had remained relatively unaffected by the fall-out, did not register any such rise in deaths amongst one-day olds. Although Chernobyl was a massive disaster and involved the release of millions of Curies of radioactivity, the affected region of Germany is more than two thousand kilometres away, and the radiation dose received by foetuses in the wombs of their mothers there, was not greater than that received regularly by foetuses in villages surrounding RAPS.**

**The British Medical Journal of 9th February, 1992 (vol.304 pp 343-6) carries a study by Prof. RK.Whyte of McMaster University, Hamilton, Ontario, Canada**

# A Note on Untoward Pregnancy Outcomes

**Untoward outcomes comprise:**

**. Complete loss of fertility resulting from the most severe degrees of damage to male or female reproduction.**

**. A reduction of fertility whether in the male or female partner.**

**. A conception which is impaired. This impairment can be due to any of the following causes.**

- **An inherited genetic defect which may have been passed through the germ-line of either parent, e.g. familial retinoblastoma or cystic fibrosis**
- **Because it may have been exposed to a mutagenic influence prior to conception leading to damage to the fetal genetic material for example, sporadic or non-familial genetic disorders**
- **Because the earliest cell divisions result in an aberrant chromosomal constitution, the origin of which may be traceable to either parent, e.g. Down's syndrome:**
- **Because it has been exposed to teratogenic (tending to produce fetal monstrosity) influences, leading to other than genetic damage, the effect often being modified by other genetic and environmental influences (multifactorial effects). Teratogens act after conception; examples would be the thalidomide drug or maternal exposures to high doses of radiation leading to fetal microcephaly.**

**From a Testimony by**
**Prof. Eva Alberman**

***Sita had a baby. Couldn't drink milk. Was soft like a quilt. He was deformed. Lived for a short while. Chousar Bai had a son. Soft, very soft. He was born dead. No movement in the abdomen for more than a month. I attended three miscarriages during the past year.***

**Kes Bol**
**Local Midwife**

**which, demonstrates a correlation between atmospheric atomic bomb test in the 50s and 60s and rise in infant mortality. The high statistical correlations indicate that there was an excess of 320,000 infant deaths in the period 1950. 1980 in the USA and UK alone. All first day infant deaths, neonatal deaths (within the first 28 days) and still-births were included in this study.**

**In a memorandum on the implications of the Whyte study, Dr Sternglass says that today, there could be millions of persons aged 10 to 45 years who have been harmed by the atomic bomb tests because some ten times more underweight babies survived who, nonetheless, frequently showed physical and mental problems. Therefore the greatest health and economic damage through fallout would not be increased rates of leukaemia and cancer among children, but instead an increase in premature and under-weight births. This would result in increased infant mortality, impaired pregnancy and immunological deficiencies in children that survive. For every thousand live births the number of underwieght babies is some 100 times greater than that of children dying from cancer and leukaemia.**

***We can see very clearly prom Table 11 and Table 14 that untoward pregnancy outcome* are significantly higher in the villages near RAPS.***