ANALYSIS OF SUB-PROFESSIONAL MANPOWER SUPPLY AND DEMAND IN NUCLEAR RELATED INDUSTRIES

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TABLE OF CONTENTS

LIST OF TABLES

Table | Page

CHAPTER I

THE PROBLEM

Introduction

This is a world of rapid technological change. It is now commonplace for whole, new technologies to emerge and develop within the period of a few years. Accelerated demand for progress on the one hand, and the emergence of increasingly complex and interrelated technologies on the other, present a major challenge to human resources planners in our nation. One of these dynamic areas of technical growth with implications for human resources development is within the field of nuclear energy.

The world entered the "atomic age" on December 2, 1942, when the first atomic reactor became critical under the direction of Dr. Enrico Fermi. Only a few scientists among the select gathering at the University of Chicago could have foreseen the potential of atomic energy harnessed for the first time that historic day. Some of the details were made public in 1945 when the first experimental atom bomb was detonated on July 16, at Alamogordo, New Mexico.

Since then, the progress has been at a steadily growing pace. Every day, new a more sophisticated uses of atomic energy are being found in every field of human endeavor ranging from agriculture to space exploration. Like any emerging technology, one of the limiting factors for still greater progress in the nuclear field is the availability of trained manpower at all levels.

Since passage of the 1954 Atomic Energy Act, a very broad based and highly technical enterprise has emerged. This enterprise represents a vast array of governmental and industrial programs and plants. In 1961, the Southern Interstate Nuclear Board (SINB), was constituted to coordinate all the activities related to atomic energy in the 17 Southern states. Puerto Rico joined the Board on May 30, 1970. SINB was the first, and for some years the only, regional coordinating unit of this type in the United States. (A complete list of all SINB member states including Puerto Rico is presented in Appendix A.)

Though the progress of nuclear industries in the South has been faster after the constitution of the Board, it has still been limited by non-availability of suitably trained manpower. One of the identified problems of SINB is to assess the current and projected trained manpower needs of the nuclear industry. There is no mechanism either at Federal, regional, or state level to gather manpower information in a format readily usable by manpower planners, especially training institutions within the region. This emphasis on manpower planning is particularly important for healthy growth of nuclear industry. SINB, therefore, is concerned at the lack of information about jobs in the nuclear industry and the training programs which create manpower pools for those jobs.

Statement of the Problem

To achieve its stated goal of continued and accelerated growth of nuclear industry in the South, SINB has manpower planning as one of its objectives. Collection and analysis of information about trained manpower demand and supply for the nuclear industry is, thus, a major concern of the Board.

Purpose of the Study

The overall purpose of this investigation is to identify and then to match nuclear related subprofessional manpower supply and demand. This interfacing will utilize data gathered within the 17 Southern states and Puerto Rico which constitute the aforementioned SINB region.

More specifically, an attempt will be made to answer the following research questions:

1. What is the magnitude of present employment at the subprofessional level in nuclear related industries by job title and type of industry within the SINB region?

2. What is the estimated demand, both present and future, of nuclear related industries for subprofessional manpower within the SINB region?

3. What training programs exist in the SINB region that attempt to meet the needs for nuclear related manpower?

4. What is the present supply and future potential supply of graduates from existing training programs within the SINB region?

5. What are some of the subsequent employment patterns of graduates from existing training programs?

6. What are the major characteristics of subprofessional workers presently employed in nuclear related industries that affect the interfacing of manpower demand and supply?

7. What training program changes will be necessary to adequately meet the subprofessional manpower needs of nuclear related industries within the SINB region?

Need for the Study

All facets of the nuclear industry have shown significant growth in recent years. Nuclear developments, including the emergence of industries and applications not known a few years ago, are now common-place and increasing. For example, in addition to industries involved with power generation and recycling of the fuel, satellite industries such as manufacture and use of radioisotopes, radiation processing of wood, concrete, chemicals and foods, instrumentation, radiography, sewage treatment, biomedical uses, marine and space application, and a host of others, have created thousands of new jobs. The nuclear industry also creates a need for services which must be met by businesses or industries with singular qualification, such as radioactive waste management and transportation of spent fuel.

As the state-of-the-art advances, so do the requirements for trained technicians, below the baccalaureate level, to fill technical and subprofessional jobs. The United States Atomic Energy Commission has estimated that between 1970 and 1976 about 5,000 additional technicians will be required by nuclear power generation industry alone which will more than double its capacity within this time period. This does not take into account the attrition and the requirements of trained personnel by other industries.[1]

Generally speaking, in the past ten years, primary emphasis in education and training in nuclear related fields of studies has been placed at the undergraduate and graduate college levels. Only token, and generally uncoordinated, efforts have been directed at training workers at subprofessional levels. These efforts have been limited, in part, by inadequate manpower demand information. The resulting manpower supply has been relatively low in quantity and mostly unrelated to the type of job opportunities in nuclear related industries.

There is an urgent national requirement to match vocational and technical education programs more closely to the actual needs of employees and to insure that, in an emerging and rapidly changing technology, well trained technicians will be ready when they are needed and in approximately the number they are needed. In order to do this, it is necessary to know what type(s) and how many technicians will be required in the various aspects of nuclear industry and what training they will require for entry level employment. It is also necessary to know what vocational and technical schools, community colleges, private technical schools, and industries are doing to meet the current and future demand.

In a report by the SINB to the member states, the executive director outlined the need for effective matching of manpower supply with demand in the following words:

> There are several basic areas that must be effectively served in order to assure an integrated favorable climate for science and technology development in the region. Among these is a technical manpower pool available, at the time, in the number, and with the degree of proficiency to parallel the growing demands of the nuclear industry which were not foreseen by industrial leaders and vocational and technical educators a few years ago. This suggests the necessity for institutions which provide vocational and technical training for employees entering the manpower market at less than the baccalaureate level to match their programs more closely to the actual needs of the industry.[2]

Limitations to the Study

The following are the limitations of this investigation:

1. Projections of manpower demand and supply were made on the assumption that economic growth of the industry and the economy will continue at the present rate. As the economy fluctuates under economic pressures, the validity of responses to the questionnaires will be limited to that extent.

2. The study is limited to the 17 southern states and Puerto Rico which constitute the region served by the Southern Interstate Nuclear Board.

3. Only a selected number of jobs at the subprofessional level are covered by this study. A committee of experts (called Steering Committee--see Appendix B for a list of members) screened and approved the number and titles of jobs to be covered. No supportive jobs, like truck drivers and office workers, were included.

4. The study is cross-sectional rather than longitudinal because of limited time. However, a base for longitudinal approach will be established.

Definition of Terms

Area Vocational School or Program - A school or program involving a larger geographical territory than a single school district. It offers specialized training to high school students, who are preparing to enter the labor market. It also provides vocational or technical education to persons who have completed or left high school and are available for full-time work.[3]

In-House Training - An organized system of training for providing workers with the skills and theoretical knowledge needed for competent performance on their jobs. The program generally involves on-the-job experiences along with classroom instruction within the premises; maybe a cooperative program sponsored jointly by industry, the school system and the organized labor working together.

Interfacing - The term interfacing will mean matching expected supply of trained manpower from specific sources by program title and description with estimated demand by job title and description. This matching of training output with job requirements will be for a given time period and within a specific geographic region. The interfacing process is characterized by clustering of selected training programs and jobs for matching purposes.

Junior College - An institution of higher education which offers the first two years of college instruction, frequently grants an associate degree, and does not grant a bachelor's degree. Offerings include transfer and/or terminal programs (with an immediate employment objective) at the post-secondary instructional level and also may include adult education programs.[4]

Manpower Demand - Demand has been defined by Reynolds as a schedule showing the number of workers employers will wish to hire at various possible wage rates.[5] For the purpose of this study, however, manpower demand will mean manpower requirements of employers over a specific period of time. It will be assumed that the employer is in a position to project his manpower requirements over a specific period of time which may extend to over ten years. These projections will be made keeping the growth of economy, present training rate, and the level of attrition constant. Estimates of manpower requirements thus derived will constitute manpower demand.

Manpower Supply - Total number of measured or projected skilled persons available during the time period under consideration, categorized according to specific skill, or specific job at current wages.[6]

Nuclear Medicine - Nuclear medicine is that clinical and scientific discipline concerned with diagnostic, therapeutic (exclusive of sealed sources) and investigative use of radionuclides.

Nuclear Related Industry - An industry involved in producing, processing, utilizing, or transporting radioactive materials. A license issued by the United States Atomic Energy Commission is a prior requirement to venture into any of the industrial activities mentioned above.

Nuclear Technology - A combination of subject matter and laboratory experiences designed for the study of scientific principles, mathematical concepts, and communicative skills. These experiences with appropriate laboratory situations, prepare the pupil to be supportive to professionals engaged in developing manufacturing, testing, research, maintaining, storing, and handling materials in the nuclear science and energy field.[7]

Private Vocational School - A school established and operated by an agency other than the state or its subdivisions, and supported by other than public funds, which has as its purpose the preparation of students for entrance into or progress in trades or other skilled occupations.[8]

Southern Interstate Nuclear Board - Is the nation's first non-federal, public supported, interstate advisory and development agency in the nuclear and space fields. It was established in 1961 by Southern Governor's Conference to help foster the sound application of nuclear and related technology in the South, in agriculture, industry, medicine, and research. The states included are: Maryland, Delaware, Virginia, West Virginia, Kentucky, Tennessee, N. Carolina, S. Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas, Missouri, Oklahoma, Texas, and Puerto Rico.

Technical Institute - A school at the post-high school level which offers technical education in one or more fields to prepare people for employment in positions which lie between those of skilled workers and professional scientists or engineers.[9]

Technician - Persons who directly or indirectly support scientists and engineers in designing, developing, producing, and maintaining machines and materials. In general, these technician jobs are technical in nature but more limited in scope than those of the engineer or scientist, and have a practical rather than a theoretical orientation.

Technician, Nuclear - A person who works as a technician in a nuclear related industry. May require a license issued by the United States Atomic Energy Commission.

FOOTNOTES

[1]*Utility Staffing for Nuclear Power*, U. S. Atomic Energy Commission, Division of Nuclear Education and Training, Pub. No. Wash-1130 (Washington, 1969), p. 6.

[2]*Nuclear and Space Development, Key Stone to Southern Progress*, Southern Interstate Nuclear Board, Report to Southern Governor's Conference (Williamsburg, Georgia, September, 1969), p. 30.

[3]Maurice W. Roney and Paul V. Braden, *Occupational Education Beyond the High School in Oklahoma*, Oklahoma State University (Stillwater, Oklahoma, 1968), p. 220.

[4]Ibid., 222.

[5]Lloyd G. Reynolds, *Labor Economics and Labor Relations*, Prentice-Hall, Inc. (Englewood Cliffs, New Jersey, 1970), p. 80.

[6]*Vocational Education and Occupations*, U. S. Department of Health, Education, and Welfare, Pub. No. OE 80016 (Washington, 1969), p. ix.

[7]Paul V. Braden, James L. Harris and Krishan K. Paul, *Occupational Training Information System*, Oklahoma State University (Stillwater, Oklahoma, 1970), p. 21.

[8]*Technical Education Yearbook, 1967-68*, (Ann Arbor, Michigan, 1967), p. 108.

[9]Maurice W. Roney and Paul V. Braden, *Occupational Education Beyond the High School in Oklahoma*, Oklahoma State University (Stillwater, Oklahoma, 1968), p. 223.

[10]Ibid., p. 224.

CHAPTER II

REVIEW OF LITERATURE

This chapter is concerned with a presentation of related research and literature that bear on the identification, explanation, or development of key concepts utilized in this study. The review of literature is divided into the following three sections:

1. Assessment of manpower requirements
2. Nuclear energy--manpower implications
3. Technician training and manpower development.

Assessment of Manpower Requirements

The following statement of Kaufman and Brown very aptly sums the dilemma of occupational education planners.

> Different approaches are possible for estimating education and training requirements. The educational planner is in a predicament. He is told, on the one hand, to use estimates of the industrial demand for manpower skills, on the other hand, to use estimates of the social demand for education. At the same time, the economist is asked to justify alternative investment decisions.[1]

On the one hand, manpower estimates lack the accuracy and sophistication required for manpower planning and on the other, meaningful planning is not possible without an accurate assessment of the jobs (demand) for which training is required (supply). In spite of efforts by different research studies, no model has yet been developed to serve the needs of both industrial manpower and education planners.

Various methods of manpower projections have been tried over a number of years and much still needs to be done. Kaufman and Brown while concluding their remarks stated that:

> . . .a forecast can seldom be more than a very sophisticated and knowledgeable guess about the future, and so should be treated only as an approximate guideline. Finally, manpower projections and analysis are concerned only with the economic effects of education; the social and other effects should also be considered.[2]

Burkett has echoed similar thoughts when he points out that:

> . . .One has only to be involved in trying to plan comprehensively for vocational education at the state level to learn that statistics on manpower needs and demographic data are not available in usable form at that level, much less at the national level.
>
> Moreover, a statistical base for local, state, or national planning is valuable only to the extent that it has validity, is interpreted with a degree of understanding, and is applied with other factors. Most labor economists are agreed that they are many years away from predicting with any accuracy the manpower needs five, ten, or fifteen years into the future.[3]

Still another economist has commented on the accuracy of manpower projections in the following terms:

> . . .the period over which we can usefully forecast the demand for manpower in the present state of knowledge is much more limited than is usually admitted. All the evidence shows that we do not yet know how to forecast beyond three or four years with anything remotely resembling the 10% margin of errors that are regarded as just tolerable in general economic forecasting.[4]

There are equally strong arguments in defense of manpower projections for educational planning. Some data, however incomplete, are preferable to no data at all since it takes out some element of "speculation" from the process of planning. Swerdloff has defended the manpower projections in the following terms:

> I cannot envision that a very large percent of decision makers or other users are likely to make implicitly projections that are more carefully thought out or

> consistent than those being developed and published. Certainly not the counselors in schools, or the program planners at the Job Corps, or the officials of most individual companies, or even those persons who might find helpful an appraisal of the adequacy of present and prospective supply of manpower in developing policy by government and industry with respect to such matters as recruitment, development of supporting workers, scholarships, expansion of research programs, etc.[5]

While this controversy is still raging the need for data, more data, and more accurate and sophisticated data is becoming critical. There is an urgent need to "leave the comfort and solace of aggregated, national data and move into the muck and mire of disaggregated local labor market data."[6]

There are, in general, three systems of manpower projections which are current at the present time. They are:

1. Econometric technique,
2. Extrapolation of trends, and
3. Employer surveys.

Many combinations of these techniques have also been used by different researchers with varying degrees of success.

The econometric technique has been used by the Bureau of Labor Statistics with considerable success. This method which is widely used by all government agencies and many research workers involves the preparation of an economic model by building up the demand for each product in an industry, the manpower requirements of each industry consistent with this demand, and finally, the development of an occupational matrix.[7] This technique is also referred to as BLS matrix technique.

Ernst and Young have outlined the seven steps in generating the BLS forecasts as follows:

1. Projection of the population by age, sex, color, and geographical distribution

2. Projection of the labor force, by age, sex, color, educational level, and state

3. Based on the assumption of minimal unemployment, an estimate is then made concerning future levels of gross national product, based on trends in productivity, hours of work, and consumer expenditures

4. These estimates of final demand are then examined for their implications in terms of industrial output at both the final stage of production as well as among the intermediate and basic industries which provide the inputs to the final production process

5. Given the final output expected from the various industrial sectors, estimates are then made of the manpower or occupational structure within each industry required to produce that output

6. These estimates of occupational employment by industry, sometimes referred to as the industry/occupational matrix or the B.L.S. matrix, may then be summed to provide the total estimated employment by occupation

7. In addition to changes in requirements as a result of growth or decline in occupational employment, estimates are made of those leaving the work force through withdrawal, death, retirement, or mobility to other occupations. These two components of future occupational need-growth and occupational losses are then summed to provide the estimate of new openings for labor force entrants.[8]

This is probably the most sophisticated technique for manpower projection but it suffers from weaknesses which make it less desirable for vocational planning at the local level. Braden and others reported in Oklahoma that planners at local and state levels found specific demand data more useful than aggregate provided by B.L.S. matrix.[9] Some of the other weaknesses are lack of sensitivity to technological changes, changes in levels of minimum employment, and educational requirements of the workers.[10]

Trend extrapolation has the advantage of speed and economy but also suffers from the same weaknesses as B.L.S. matrix.

The farther in time projections are made the less likely the assumption of similarity of trends will hold. "One of the reasons that we have manpower problems is that the past has not served as a sufficient indicator for human resources development policies."[11]

Employer surveys have been maligned and lauded by different researchers at different times and in different situations. Its critics argue that very few employers are knowledgeable enough to make meaningful projections. Also, some employers are hesitant to disclose their requirement fearing that their competitors will take advantage of the information. Mobility of labor also undermines the accuracy of such surveys. Other researchers have defended the technique pointing out the speed, economy, and efficiency with which data can be gathered. Levitan justified the use of employer surveys in the following terms:

> It is not at all clear, however, that the technical shortcomings of Area Skill Surveys present serious impediments to formulators of educational policy. Knowledge of general trends should be adequate to plan for the expansion of needed facilities and programs and retrenchment in others. The details as to specific courses can be implemented on a case-by-case basis and should normally require a short lead time. The fact that area skill projections have no way of taking into account the demand of new employers starting after a survey is completed should not constitute a serious obstacle to educational planning. It might be taken for granted that any new major employer in an area would consult with school authorities or the public employment service about his anticipated skill needs, or that the news would become sufficiently widespread within the community and available to the school authorities, even if a prospective major employer failed to advise the school authorities of his plans. The school authorities could then revise their planning in line with the new developments. However, in practice, it would appear the lines of communication between employers and educators frequently break down and that schools are not always responsive to the needs of employers.[12]

In Oklahoma, while working on the development of an Occupational Training Information System, Braden and others concluded that:

> Many decision makers in Oklahoma feel that if occupational training programs are to contribute maximally to the economic growth of Oklahoma, micro-manpower demand data must be analyzed on a specific, systematic and continuing basis.[13]

A feature of the employer survey method used in Oklahoma was the use of vocational educators to collect the manpower data. This feature is described by the authors in the following terms:

> The survey was unique not only in the fact that an attempt was made to personally contact all manufacturing establishments in the state, but also in the identity of the individuals who surveyed these industries. The data collectors were primarily vocational and technical education instructors and supervisors who were carefully selected as to their future responsibilities with industrial coordination. These key persons remained in their particular districts after the project was completed. This contributed significantly to the school-industry liaison picture in the various regions of the state. Many have now become industrial coordinators or work closely with someone in that area of responsibility. <u>All area vocational-technical schools now have industrial training coordinators</u> or are completing arrangements in this vital area. The information collected by them is available by business establishment and county. In addition, the information was presented to the Oklahoma Employment Security Commission for use in updating their 1967 data and was available for official school use in curriculum planning on a local and statewide basis.
>
> All data collectors agreed that the personal interview approach was successful in developing rapport between vocational and technical educators and industrial manpower planners. This liaison will serve as a basis for continuous communication between these groups.[14]

Another important feature of the Oklahoma system was the interfacing of job clusters with the training program clusters. Vocational education programs were matched with jobs on which the graduates of the aforementioned programs could be placed. This technique of clustering training programs with jobs was developed by the United States

Department of Health, Education, and Welfare, but was validated for the first time in Oklahoma.[15]

Oklahoma system analyzed supply and demand data related to 384 jobs which were grouped into 91 job clusters. Holmes found these clusters to be valid since most of the graduates from the training programs were placed on jobs within the clusters. However, he went on to report that:

> ...Significant differences were found in employment patterns with an apparent need for restructuring some vocational programs relative to the seven program service divisions. Validation of supply - demand data is necessary if a realistic picture of existing conditions is to be accomplished.[16]

Nuclear Energy--Manpower Implications

The U. S. Atomic Energy Commission in cooperation with the Bureau of Labor Statistics has undertaken to assess the manpower needs of nuclear industry for the next decade. Their report is expected to be published soon. In one of their earliest publications, however, they reported that between 1963 and 1968 the number of technicians in the nuclear field, excluding radiologic technicians, increased from 22,347 to 25,446, an increase of 14 percent, over a period of five years. According to this report, the "Technicians" were the largest of the three defined occupational groups in 1968, with 25,400 employed by establishments engaged in atomic energy activities.[17]

Though new and varied uses are being found in nuclear energy almost every day, the most profound impact of this source of energy has been in the fields of power generation and health industries. Its impact on industrial research is also considerable. Of all these peaceful uses of atomic energy the industry which has the greatest implications for manpower is power generation. Thousands of highly trained workmen are required to construct, fuel, operate, maintain, and overhaul the nuclear power plants. A still larger number of workers is required to provide these technicians with adequate support. The U. S. Atomic Energy Commission, in a publication entitled Utility Staffing for Nuclear Power, estimated that 47 highly trained technicians were required for a nuclear power plant. These requirements, though they would vary from plant to plant, would be slightly less if new units were added to an existing plant.[18]

The Atomic Energy Commission reported data on the 111 atomic reactors which were planned to go into operation between 1969 and 1976. According to the A.E.C., a total of 4,768 trained technicians with some training in nuclear energy would be required to operate these reactors. No effort was made in this report to project the number of support personnel or the total manpower requirements of the industry.[19]

SINB, on the other hand, reported that there are 31 power plants scheduled to be completed in the period 1970-1977. According to SINB:

> Within the SINB region it is estimated that there will be 50 to 60 nuclear power reactors by 1980 with a generating capacity of 52,000 Mwe and that 193,000 Mwe of nuclear power will be required by 1990. This leaves an additional requirement of over 166,000 Mwe for which sites must be selected.[20]

SINB also reported an employment of 39,187 on May, 1969, which did not include people employed in turbine and reactor component manufacturing, supply services, radioactive materials transportation, etc.[21] Again, no effort was made to assess the total nuclear related manpower needs of the SINB region for achievement of a quadrupled nuclear power generation by 1990.

A survey conducted by Edison Electric Institute projected a need for 2,500 to 5,000 engineers per year for power generation industry during the 70's. These projections have obvious implications for technician employment. According to the authors of this report:

> . . .Many companies are finding that technicians are able to carry out much of the routine technical work formerly assigned to engineers. As a result, the number of technicians employed by the electric utility industry appears on the upswing. Technician needs in the future are estimated at 600 per year for designers, draftsmen, surveyors, layout men, test-personnel, and similar functions.[22]

Another important and perhaps the most noticeable effect of nuclear energy is in the health field. The number of X-ray technicians has variously been estimated at between 30,000 and 75,000.[23] The latter estimate, however, includes those working part-time. According to the Department of Labor report, which also listed X-ray technicians as one of the 17 most critical occupations in the health field:

> New techniques are being used widely in the treatment of cancer by various types of radiation devices, providing X-rays and gamma rays; equipment utilizing high speed electrons is used in treating certain skin lesions. Hodgkin's disease, a type of cancer, is being treated with energy from linear accelerators.[24]

The same report further goes on to estimate the total number of X-ray technicians at 52,000 in 1975.

A more liberal estimate of the X-ray technician was made by Howard L. McMartin, when speaking in a conference on X-ray Technician Manpower. His figure of 75,000, however, included those not registered as well as those working part-time. From a sample of 1,129 technicians working in some 6,000 establishments in nine states he reported that on an average the hospitals, big and small, employ eight X-ray technicians per thousand beds (the ratio is higher in small hospitals than in big ones); 29 percent of the private offices employ X-ray technicians; and 66 percent of the clinics employ such technicians. The figures quoted above were for full-time employees only. There were as many as 6,470 technicians who were working part-time.[25]

No estimate could be found of the number of people working as Radiation Therapists or otherwise involved in nuclear health work at technician level.

Due to historical developments, and especially due to its importance as a defense industry, research and development play a dominant role in the field of nuclear energy. There are only a few privately owned research laboratories in America. Most of the research laboratories are government-owned and contractor operated, whereas only a few are owned and operated by the federal government. Out of a total of 25,400 technicians employed in 1968 in all the fields of nuclear energy, 11,100, or 43 percent, were involved in research.[26]

There is no indication that this trend will change in the foreseeable future because the importance of nuclear energy and its uses, both peaceful and for defense, will continue to demand a high level of research activity.

Though nuclear industry is still in its infancy, its potential in fields like agriculture, oil exploration and drilling, and transportation is already being recognized as tremendous. Martin Mann, in his book Peacetime Uses of Atomic Energy, points out that atomic energy is a boon to the farmers and has the potential to feed the hungry billions of this planet. Radioisotopes are being used for research into the process of photosynthesis by which the plants grow. Other radioactive materials help to eradicate plant diseases and effective pest control; they help in treating seeds to get bigger for heavier crops; and they help the plants to grow faster than they would under the natural circumstances.[27]

Similar revolutions in production techniques, testing procedures and development of new products are being brought about in many industries. The role of industrial radiography, in this context, is worthy of special attention because this new and emerging field tends to overshadow the old testing techniques used by the industry. According to Mann, "Atomic measuring devices alone were saving American Industry $3,000,000,000 every year."[28]

No estimates, at present, are available of the manpower needs, present or future, for this vast array of jobs. In 1968 there were only 408 industrial radiographers employed in the country which represented only three percent of the total employment in nuclear related industry.[29]

Other industries, such as uranium milling, fuel element fabrication, instrument manufacturing, radioactive waste disposal, etc., between them employed 6,500 technicians.[30] Greater demand for nuclear power and other services will increase employment in these segments of the industry also.

Technician Training and Manpower Development

In spite of a concerted effort by researchers, the term "technician" still defies a clear and precise definition. Whereas the Bureau of Labor Statistics refers to technicians as those "workers who must have training comparable to that obtained in a two-year technical institute," there are other studies which tend to define the term more liberally. To further complicate the problem, different employers use different titles for individuals doing the same work. According to a report by the U. S. Department of Labor:

. . .Definite guidelines would be established in de-developing all statistics on technician manpower. If guidelines are not used, the data will not be comparable, and analysts will not be able to build upon the information collected by others - - a key research objective. Such a system is now being developed as part of a Bureau of Budget Committee's work on developing a standard occupational classification system.[31]

One of the more notable efforts in this direction--to define "technician"--was by Roney and Braden. According to them, a technician is:

. . .A person who directly or indirectly supports scientists and engineers in designing, developing, producing, and maintaining machines and materials. In general, these technician jobs are technical in nature but more limited in scope than those of the engineer or scientist, and have a practical rather than a theoretical orientation.[32]

The U. S. Bureau of Labor Statistics has also a similar definition for "technician", but they have specifically mentioned that:

Excluded from coverage are: (1) Technicians who work with physicians, dentists, and other practitioners in patient care; (2) workers who fall in the "spectrum of middle level manpower" in business-related technologies and public services such as library assistants and level secretaries; and (3) workers classified as craftsmen such as instrument repairmen and mechanics.[33]

Roney and Phillips, on the other hand, contend that there are three generations of technicians. According to them, first and second generation technicians are somewhere between the skilled workmen and the engineers, highly skilled in their particular field, and work in support of engineers and scientists. The third generation of technicians, however, differ from their first and second generation brethren "in the mathematics and science base required . . . and in a shift from procedural and manipulative skills to cognitive and analytical skills." The authors go on to explain that:

The third generation of education will cut across established fields of technology. This generation will provide

> new combinations of technical skills and knowledge built around a core of the sciences. Applications of the sciences will be drawn from modern industrial activities, and the "specialized" content of the instructional program will be systems oriented, rather than field oriented.[34]

It is in this context of third generation of technical personnel that a nuclear technician is referred to. The training of this type of technician involves a study of "nuclear physics, radioisotopes, chemistry, electronics, nuclear instrumentation, and safety procedures."[35] Besides this interdisciplinary education, the technician must go through an extensive on-the-job training to acquire the particular skill which he would be required to perform. Several training programs have been initiated but their number and output is small as compared to projected need for technician manpower.[36]

Technological innovations and improvements can be taken advantage of only by trained manpower. This view is stated by Morton in the following words:

> Colleges and universities, business, and industry may generate innovative ideas, new and advanced scientific breakthroughs, and theories which will assist us in solving the problems of today's society. But the applied sciences necessary to bridge the gap between theory and implementation are ours to deal with. Conversion of theory, innovative thinking, innovative scientific advances, and the training of persons to implement the systems generated by our graduate institutions and by business and industry are our problems to solve. Should we fail to find the capability to deal with them effectively in the next few years we may be assured that the twenty-first century will indeed belong to someone else.[37]

Venn has echoed similar thoughts when he exhorted educators to take up the challenge of training technicians not only in sufficient numbers but also in good quality. He stated:

> . . .Thus, while the very shortage of technical personnel makes it imperative that these avenues [other

than educational] to technical employment be kept open, it is fatuous to suggest that, taken together, they can meet the future. The only hope for providing the quantity of technical manpower needed lies with the educational system.

The problem is not simply one of numbers. It's one of quality. Though unplanned routes may lead to eventual employment designated as "technical," what kind of technicians do these sources produce? . . .The technical occupations today form a vital and responsible part of science and engineering, and they demand personnel with the background and education increasingly possible only through organized technical education curricula within the educational system.[38]

The National Industrial Conference Board has estimated a need of 1,198,000 technicians by the year 1975. According to them:

On the basis of data that have become available since the 1966 publication of the BLS Bulletin 1512, approximately 1,315,000 engineers, 602,000 scientists, and 1,198,000 technicians will be needed in 1975. These 1975 projections imply increases from 1968 employment levels of 23% for engineers, 29% for scientists, and 24% for technicians, or average annual compound rates of growth of 3.0%, 3.8%, and 3.1%, respectively... In order to meet the 1975 demand for technical manpower, the estimated number of new entrants needed between 1968 and 1975 for growth and replacement (of those who die, retire, or transfer to other fields) is some 510,000 engineers, 292,000 scientists, and 560,000 technicians.[39]

As against this demand the authors estimated that only about 40% to 45% of the demand for new technicians is expected to be met by the post-secondary technical program. Another 25% to 30% will be met by upgrading of present workers through in-house training and through other sources. There will still remain a shortage of about 25% to 35%, or 160,000 to 220,000 technicians within the six year period.[40]

A similar picture is painted by the Bureau of Labor Statistics while projecting the manpower demand in 1980. According to them there will be 9 million (about 6 million growth and 3 million replacement) net job openings between 1968-1980 among professional and technical workers.

This represents an annual rate of 3.4% increase in demand for these kinds of jobs.[41] To meet this challenge a bigger commitment by the nation to technical education and bigger efforts by the technical educators are clearly indicated.

In summary, it may, however, be pointed out that, as Braden and others have stated:

> It should be understood that considerations of manpower supply and demand are not the only criteria for statewide manpower planning. There are other and very important factors. But unless economic impact of education is to be given no weight at all, some form of manpower planning is both desirable and inevitable.[42]

This manpower planning needs serious consideration by economic and educational planners as per the Manpower Report of the President:

> Efforts to solve labor shortages cannot stop with ex post facto evaluations and action. The time to deal with manpower shortages is before they develop. . . A comprehensive system of reporting on occupational training would add greatly in appraising achievements and needs and in coordinating Federal training programs with private industry's much larger training activities.[43]

A survey of literature presented on the preceding pages can be summarized as follows:

1. There is no manpower projection technique comprehensive and refined enough to serve the needs of all planners.

2. In spite of serious limitations, the employer survey technique is still the best manpower projection technique available to educational planners at state and local levels.

3. There is a gap of information related to the manpower needs of the nuclear industry, especially in the SINB region.

4. Educational system of the country should gear itself to the trained manpower requirements of the economy, especially in new and emerging technologies.

The following chapters will report the type of data collected for the conduct of this study. Data collection procedures, analyses of data, and the conclusions drawn therefrom will also be reported in the following pages.

FOOTNOTES

[1] Jacob J. Kaufman and Anne F. Brown, "Manpower Supply and Demand," Review of Educational Research, October, 1958, p. 329.

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[3] Lowell A. Burkett, "It's Impossible. Period," American Vocational Journal, March, 1971, p. 26.

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[17]United States Atomic Energy Commission, Occupational Employment Trends in the Atomic Energy Field 1963-1968 (Washington, 1969), pp. 1-3.

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[21]Ibid., p. 10.

[22]Edison Electric Institute, Engineering Manpower Needs of the Investor-Owned Electric Utility Industry (New York, 1968), p. 10.

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[29]United States Atomic Energy Commission, Occupational Employment Trends in the Atomic Energy Field 1963-1968 (Washington, 1969), p. 25.

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[32]Maurice W. Roney and Paul V. Braden, Occupational Education in the High School (Stillwater, Oklahoma, September, 1967), p. 21.

[33]United States Department of Labor, Technician Manpower 1966-80, p. 25.

[34]Maurice W. Roney and Donald S. Phillips, Electromechanical Technology (Washington, 1970), pp. 9-10.

[35]United States Department of Health, Education, and Welfare, Standard Terminology for Curriculum and Instruction in State and Local School Systems (Washington, 1969), p. 645.

[36]United States Atomic Energy Commission, Utility Staffing for Nuclear Power (Washington, Publication 1130, July, 1969), p. 23.

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[41]United States Department of Labor, The U. S. Economy in 1980: A Preview of BLS Projections (Washington, 1970), pp. 21-22.

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CHAPTER III

METHODOLOGY

Introduction

The purpose of this chapter is to outline the procedures and tools used in an attempt to answer the research questions posed in this study. Procedures for selection of population, instrumentation, and data analysis are also presented.

Design Rationale

The basic design of this study can be characterized as descriptive survey research. Manpower research and development has for some time been a sole concern, and preserve, of economists. Involvement of educators in this field is a relatively recent development. The nature of the subject, however, is such that survey research is best suited to deal with the dynamic problem encountered in manpower research. Chamberlain opines:

> If economists want to be "scientific" and therefore quantitative, they are obliged to a short enough run for the phenomena with which they work to stay relatively fixed--where changes are so moderate or incremental as not to invalidate logic based on a continuity of circumstances. If economists want to deal with a farther future, which increasingly involves not only change but change which is planned for, they are obliged to work with other standards than efficiency and with methods that are judgemental and strategy oriented rather than scientific.[1]

Van Dalen also advocated a descriptive approach to research where the variables are not yet well defined. According to him:

> Before much progress can be made in solving problems, men must possess description of the phenomena with which they work. Early developments in educational research, therefore, as in other disciplines, have been concerned with making accurate assessments of the incidence, distribution, and relationships of phenomena in the field. But descriptive research is not confined to routine fact gathering. Predicting and identifying relationships among and between variables is the goal of competent investigators.[2]

Survey research, however, has some limitations chief among which are the sacrifice of "depth" for the sake of "scope", time, and money.[3] The investigator is aware of these limitations and caution will be used in the interpretation of the results of this study.

Populations

Demand

Any firm or establishment that manufactures, processes or utilizes nuclear material or product thereof must obtain a license from the United States Atomic Energy Commission (hereafter referred to as AEC). It may, however, be pointed out that application for and issuance of such a license is indicative of intentions only and does not commit the applicant to the process or the product. A list of 1,588 licensee firms within the SINB region was acquired through AEC. A letter was written in September, 1970 to these 1,588 firms asking them to identify a "keyman" in their firm who could be contacted later to fill in demand questionnaires. A reply paid post card was enclosed with the letter for the convenience of respondents. (See Appendix C for "keyman" letter and the reply paid post card.) Responses were received from 378 firms which represented a 23.8 percent return.

Demand questionnaire was mailed to all the 1,588 firms as described earlier in December, 1970. Different forwarding letters were used for those who did respond to the earlier introductory letter and those who did not. (The letters can be seen in Appendix D.) This was done to increase the probability of a high response.

On January 4, 1971, a reminder post card was sent to all the non-respondents. The "keyman" nonrespondents, however, were sent a personalized letter by the Director of SINB. (See Appendix E for both these letters.)

Table I shows the results of these efforts and the total returns received.

TABLE I

RESPONSE ANALYSIS OF DEMAND QUESTIONNAIRE

Questionnaires	Number	Percent
Mailed	1588	100.0
Returned	682	42.9
Usable Returns	418	26.3
*Not Usable Returns	264	16.6
Nonrespondents	906	57.1

*Not Usable are those questionnaires which indicated that the firm did not employ any nuclear technicians.

To check for a possible bias in the returns a sample of 92 firms was randomly selected and a telephone contact was established with them. The results of this check are reported in Table II.

TABLE II

RESPONSES ON THE BIAS-CHECK TELEPHONE SURVEY

Firms Contacted	Number	Percent
Sample	92	100.0
Firms Employing Technicians	31	33.7
Firms Not Employing Technicians	43	46.7
No Longer Licensees	9	9.8
No Response	9	9.8

The responses represented in Table I and Table II were dichotomized between those returns which are usable and others, and the results are presented in Table III.

TABLE III

COMPARISON OF RESULTS OF THE RESPONSES TO QUESTIONNAIRES AND TELEPHONE SURVEY RESPECTIVELY

Firms Contacted	Demand Questionnaire	Telephone Survey
Firms Employing Technicians	418	31
Others	1170	61
Total	1588	92

A calculated chi square value of 2.40 was not significant at the 0.05 level of significance with one degree of freedom. (Table value 3.841 with 1 d.f.) This shows that no significant differences exist between the population of firms represented by the list supplied by AEC and the nonrespondents represented by the bias check sample.

A further analysis of the 31 firms from the bias-check sample which employed technicians also showed that 15 or 48.4 percent employed less than 5 technicians and 11 or 35.5 percent employed only one technician.

It is, however, conceded that all demand is not accounted for by the returned questionnaires. Therefore, no effort is made in subsequent analysis to generalize beyond the 418 organizations that indicated need for technician manpower. The present and future manpower needs of these 418 firms for jobs covered by this study will constitute the demand population.

Supply

Supply questionnaire was sent to 656 public and private schools, junior colleges, hospitals, and universities in the SINB region that offer post-secondary technical training. The results of the responses are presented in Table IV.

TABLE IV

RESPONSES TO SUPPLY QUESTIONNAIRE

Institutions Contacted	Number	Percent
Mailed Questionnaires	656	100.0
Responses	389	59.2
Institutions that offer Training Programs	99	15.0
Institutions that do not offer Training Programs (nuclear or related)	290	44.2

A randomly selected 36 institutions from among the nonrespondents were contacted by telephone. Only one of these institutions was found to offer a training program. For the sake of this study, therefore, it will be assumed that the responding 99 institutions represent the training programs for nuclear technicians in SINB region. The graduates from these institutions will constitute the supply population of this study.

Instrumentation

Two basic instruments were developed for data collection. They were:

1. Demand Questionnaire (See Appendix F.) and,
2. Supply Questionnaire (See Appendix G.).

The instruments were developed with the help of both technical educators and employers. They were discussed and refined by the Steering Committee in their meeting on October 29, 1970, at Atlanta, Georgia. The instruments were pretested at selected schools and employing establishments recommended by the SINB Deputy Director.

A secondary instrument was developed to collect educational and work-experience background of technicians working in randomly selected organizations. (See Appendix H for the instrument.)

The Samples

Samples were drawn from the two populations mentioned in the previous section. From the respondent employing organizations a sample of twenty was randomly selected. Each of the respondent firms was listed in alphabetical order by state and was assigned a distinct numerical code. A table of random numbers was used to finally select the sample. After the selection, two firms were found to be employing part-time technicians only. These two were replaced by two other randomly selected firms. This sample was utilized to administer by mail the technician educational background instrument.

A similar procedure was adopted to select a sample of twenty from the training institutions also. A table of random numbers was used to select this sample to conduct a survey by telephone, explained in the next section.

Data Collection

Mailed Questionnaires

The principal method of data collection was by mailed questionnaire. All questionnaires and reminders were mailed under the signature of SINB officials to ensure better returns. The following chronology represents different phases of data collection and other significant activities relating to this study.

1. Early contacts were established with SINB for sponsorship of the project--June, 1970.
2. Initial strategy was outlined and different phases were discussed with the Deputy Director SINB--July 17, 1970.
3. Steering Committee was selected to advise on the project--August, 1970.
4. Initial letter for identification of "keyman" mailed by SINB--September, 1970.
5. Series of meetings were held with nuclear technology teachers and employers to discuss the draft instrument--September, 1970.
6. Draft instruments were discussed in Steering Committee meetings in Atlanta, Georgia, and further revised on members' advice--October, 1970.
7. Demand and supply questionnaires were mailed to all the firms and institutions--November-December, 1970.
8. Reminder cards and letters were mailed to the nonrespondents--January, 1971.

9. Progress report was presented to the SINB officials at Stillwater, Oklahoma--January, 1971.
10. Sample of nonrespondents was selected for telephone contacts--February, 1971.
11. Draft questionnaire for technician background was discussed with educators and employers--March, 1971.
12. Samples for demand and supply follow up were drawn--March, 1971.
13. Questionnaires for technician background mailed to the selected firms--April, 1971.
14. Selected institutions were interviewed on telephone for graduate follow-up--April, 1971.
15. Data were analyzed--April-May, 1971.

Technician Education Background Instrument

Twenty employing organizations that constituted the sample were mailed a questionnaire with a forwarding letter from the Executive Director of SINB. (See Appendix H for instrument and Appendix I for forwarding letter.) The total technician employment of these firms was 2,321. The returns from this instrument provide data in educational and work experience background of the technicians working on nuclear related jobs in order to provide additional information for the difficult job of matching manpower supply and demand.

Telephone Interviews

Twenty training organizations which constituted the sample for supply population were contacted by telephone. Telephone interview technique was found useful to conduct a graduate follow-up from the selected institutions, who had earlier identified their representatives by name and designation. These representatives were asked a series of questions on telephone to gather data on the employment pattern of their graduates from the most recent graduating class. (See Appendix J for telephone interview form.) In most of the cases the required information was readily available. In some cases, however, more than one telephone calls were necessary to elicit the required information.

This method of following up graduates through school officials--mostly teachers--rather than the graduates themselves was used because of time and resource limitations. Frazier and Harris recommended the use of teacher follow-up as it was less costly and time consuming. According to them, follow up through the teacher should be continued till a better method can be developed.[4]

Data Analysis

After verification, the data were coded and punched on electronic processing cards. Facilities of the Computer Center at Oklahoma State University were utilized to process the data which were placed on magnetic tape.

Percentages and frequency counts have been used to determine the distribution of responses to all questionnaires. As already mentioned earlier in this chapter, this study is concerned with the scope rather than the depth of trained manpower problem of the nuclear related industries in the SINB region. Percentage and frequency analysis have been found very useful in this kind of research design.

Summary

General procedures for this study were studied in this chapter and major events in the chronology of the study were outlined. Manpower demand and supply data were collected from 418 employer organizations and 99 training institutions. The procedures outlined also reported the drawing of random samples from the supply and demand populations. These samples were drawn to study the job behavior patterns of graduates from training programs and selected characteristics of subprofessional workers in nuclear related industries.

Instruments to collect data were developed in close cooperation with the project steering committee and SINB officials who also helped in data collection at almost all stages. The next chapter will present the analysis of data collected through this joint effort.

FOOTNOTES

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CHAPTER IV

ANALYSIS OF DATA

Introduction

The purpose of this study has been to try to answer the following research questions:

1. What is the magnitude of present employment at the subprofessional level in nuclear related industries by job title and type of industry within the SINB region?

2. What is the estimated demand, both present and future, of nuclear related industries for subprofessional manpower within the SINB region?

3. What training programs exist in the SINB region that attempt to meet the needs for nuclear related manpower?

4. What is the present supply and future potential supply of graduates from existing training programs within the SINB region?

5. What are some of the subsequent employment patterns of graduates from existing training programs?

6. What are some of the major characteristics of subprofessional workers presently employed in nuclear related industries that affect the interfacing of manpower demand and supply?

7. What training program changes will be necessary to adequately meet the subprofessional manpower needs of nuclear related industries within the SINB region?

Data pertaining to these research questions will be presented in the following sections:

1. Manpower Demand
2. Manpower Supply
3. Worker Profiles, and
4. Interfacing of Manpower Demand and Supply.

An effort is made by the investigator to first, analyze the separate factors relating to deriving net manpower requirements, and second, to bring these factors to bear on the actual interfacing of job and training program clusters. The interfacing of clusters is rendered in aggregate form for the entire SINB region. No attempt has been made to analyze the net manpower requirements for any individual state or territory.

Analysis of Manpower Demand

Present employment of the subprofessional manpower in the nuclear related industry is indicated in Table V. The jobs have been divided into four clusters on the basis of their relationship to broad industrial classifications. These clusters are as follows:

1. Power, Production and Related Jobs.
2. Testing, Monitoring and Related Jobs.
3. Health Related Jobs.
4. Other Related Jobs.

It may be seen from Table V that the greatest diversification in the jobs is in the "Other Related Jobs" cluster.

All the jobs surveyed added to a total employment of 8,547, of which 17.9 percent were employed in the "Power, Production and Related Jobs" cluster, 24.4 percent in the "Testing, Monitoring and Related Jobs" cluster, 24.6 percent in the "Health Related Jobs" cluster, and 33.1 percent in the "Other Related Jobs" cluster.

TABLE V

PRESENT EMPLOYMENT LEVEL OF SELECTED SUBPROFESSIONAL JOBS
IN NUCLEAR RELATED INDUSTRIES WITHIN SINB REGION

Job Title	Number Presently Employed	Percentages Within The Cluster	Cluster As A Percentage Of All Jobs
Power, Production and Related Jobs			
Test or Research Reactor Operator	84	5.5	
Production, Test or Research Reactor Operator-Government Owned	118	7.7	
Accelerator Operator	81	5.3	
Radioisotope-Production Operator	124	8.1	
Nuclear Power Plant Operator	132	8.6	
Hot-Cell Technician	75	4.9	
Nuclear Material Processor, Senior	349	22.8	
Nuclear Facility Equipment Operator	273	17.8	
Nuclear Facility Maintenance Technician	296	19.3	
Total	1,532	100.0	17.9

TABLE V (Continued)

Job Title	Number Presently Employed	Percentage Within The Cluster	Cluster As A Percentage Of All Jobs
<u>Testing, Monitoring, and Related Jobs</u>			
Radiation Control Technician	323	15.5	
Nuclear Facility Chemistry (Radiochemistry) Technician	273	13.1	
Non-Destructive Testing Technician	596	28.6	
Instrumentation and Control Technician	352	16.9	
X-Ray Calibration Technician	45	2.2	
Well Logging Technician	493	23.7	
Total	2,082	100.0	24.4
<u>Health Related Jobs</u>			
Radiologic Technologist	1,108	52.7	
Radiologic Technologist, Chief	148	7.0	
Nuclear Medical Technologist	297	14.1	
Chest Radiographer	24	1.1	
Urology X-ray Technician	31	1.5	

TABLE V (Continued)

Job Title	Number Presently Employed	Percentage Within The Cluster	Cluster As A Percentage Of All Jobs
Health Related Jobs (Continued)			
Orthopedic Radiologic Technician	60	2.8	
Special Procedures Technician	105	5.0	
Radiation Therapy Technician	132	6.3	
Internal Dosimetry Technician	15	0.7	
Radiobiology Technician	111	5.3	
Radiopharmacist	73	3.5	
Total	2,104	100.0	24.6
Other Nuclear Related Jobs			
Soils Evaluation Technician	418	14.8	
Draftsman	482	17.0	
Computer Programmer	166	5.9	
Mechanical and Structural Technician	597	21.1	
Welding Technician	275	9.7	

TABLE V (Continued)

Job Title	Number Presently Employed	Percentage Within The Cluster	Cluster As A Percentage Of All Jobs
Other Nuclear Related Jobs (Continued)			
Electronic and Instrument Technician	555	19.6	
Quality Control and/or Quality Assurance Specialist	336	11.9	
Total	2,829	100.0	33.1
Grand Total of All Jobs	8,547		100.0

Among the power, production, and related jobs, reactor operators, whether research, production, or accelerator, account for 26.6 percent of the jobs. Over half the jobs are divided among different types of nuclear equipment operators.

About one half of the jobs in the "Testing, Monitoring and Related Jobs" cluster are held by non-destructive testing technicians and well logging technicians. The rest are almost evenly divided among other testing technicians.

In health related jobs, the largest numbers are represented by radiologic technologists, accounting for 59.7 percent of the jobs. Nuclear medical technicians hold 14.1 percent of the jobs, whereas, the remainder representing some 26.2 percent of the jobs, are divided among other health related technicians.

Other nuclear related jobs are almost equally divided among soil evaluation technicians, draftsmen, electronics, and mechanical technicians.

Projected demand of nuclear related technicians for selected years between 1971 and 1975 is reported in Table VI. From the Table it can be seen that within the next five years the demand for power, production, and other related technician jobs will increase by 1,726. For testing technicians, health related technicians, and other technicians, the corresponding increase in demand is represented by 4,174; 5,232 and 5,275 respectively, making a total of 16,407. This represents a demand of 3,281 nuclear related technicians per year for the next five years, when the total is divided by the appropriate number of years.

TABLE VI

PROJECTED DEMAND OF SUBPROFESSIONAL NUCLEAR RELATED MANPOWER WITHIN SINB REGION FOR SELECTED YEARS BETWEEN 1971 THROUGH 1975

Job Title	Projected Demand Estimated for the Years			Total
	1971	1972-73	1974-75	
Power, Production and Related Jobs				
Test or Research Reactor Operator	44	54	54	152
Production, Test or Research Reactor Operator-Government Owned	9	12	12	33
Accelerator Operator	27	36	41	104
Radioisotope-Production Operator	50	65	19	134
Nuclear Power Plant Operator	69	129	163	361
Nuclear Material Processor, Senior	14	25	29	68
Hot-Cell Technician	5	11	16	32
Nuclear Facility Equipment Operator	86	157	166	409
Nuclear Facility Maintenance Technician	92	188	153	433
Total	396	677	653	1,726

TABLE VI (Continued)

Job Title	Projected Demand Estimated for the Years 1971	1972-73	1974-75	Total
Testing, Monitoring and Related Jobs				
Radiation Control Technician	142	195	196	533
Nuclear Facility Chemistry (Radiochemistry) Technician	57	98	107	262
Non-Destructive Testing Technician	325	416	433	1,174
Instrumentation and Control Technician	124	186	213	523
X-ray Calibration Technician	35	49	60	144
Well-Logging Technician	477	530	531	1,538
Total	1,160	1,474	1,540	4,174
Health Related Jobs				
Radiologic Technologist	761	925	1,019	2,705
Radiologic Technologist, Chief	121	132	154	407
Nuclear Medical Technologist	233	307	349	889
Chest Radiographer	20	27	27	74
Urology X-ray Technician	18	24	33	75

TABLE VI (Continued)

Job Title	Projected Demand Estimated for the Years 1971	1972-73	1974-75	Total
Health Related Jobs (Continued)				
Orthopedic Radiologic Technician	40	45	55	140
Special Procedures Technician	89	128	142	359
Radiation Therapy Technician	101	126	147	374
Internal Dosimetry Technician	5	14	15	34
Radiobiology Technician	26	31	38	95
Radiopharmacist	13	29	38	80
Total	1,427	1,788	2,017	5,232
Other Nuclear Related Jobs				
Soils Evaluation Technician	418	529	643	1,590
Draftsman	214	198	239	651
Computer Programmer	64	120	136	320
Mechanical and Structural Technician	265	363	476	1,104
Welding Technician	87	110	131	328

TABLE VI (Continued)

Job Title	Projected Demand Estimated for the Years: 1971	1972-73	1974-75	Total
Other Nuclear Related Jobs (Continued)				
Electronic and Instrument Technician	252	392	196	840
Quality Control and/or Quality Assurance Specialist	137	178	127	442
Total	1,437	1,890	1,948	5,275
Grand Total of All Jobs	4,420	5,829	6,158	16,407

Analysis of Manpower Supply

There are three major sources of specific technician training within the SINB region. These are:

1. Schools - Junior and community colleges, technical institutes, private schools, and universities.

2. Hospitals

3. Industries -- In-house training

Table VII indicates the number of training programs by type of organization.

TABLE VII

NUMBER OF NUCLEAR RELATED TRAINING PROGRAMS
BY TYPE OF TRAINING ORGANIZATION

Type of Organization	Number	Number of Training Programs
*Schools	37	55
*Hospitals	62	82
Industries	130	180

*Only formal training programs are included. In-house training by industry or hospitals is included in the "Industries" category.

It may be seen from the table that industry provides about fifty percent more training programs than the schools and hospitals combined. Most of the industrial programs, however, are of short duration for upgrading purposes only.

Employing organizations which responded to the demand questionnaire were asked to indicate whether they would hire the graduates from school programs, if such were available, instead of training the workers themselves. Their responses are reported in Table XIII.

TABLE VIII

RESPONSE OF EMPLOYING ORGANIZATIONS TO THE QUESTION WHETHER THEY WILL HIRE SCHOOL TRAINING PROGRAM GRADUATES

Employing Organization	Will Hire	Will Not Hire	No Response
Those having in-house training	119	11	0
Those who do not have in-house training program	144	46	98
Total	263	57	98

It may be seen from Table VIII, that only 13.6 percent of the responding employers indicated that they will not hire graduates from school training programs. More than ninety percent of those employers who have their own in-house training programs indicated willingness to hire such graduates, if they are available with appropriate training and in appropriate numbers.

Present enrollment and projected supply of nuclear technicians from schools and hospitals is presented in Table IX. It may be seen from the table that in a five year period from 1971 through 1975, a total of 4,565 technicians are estimated to be trained by public and private schools and hospitals.

Graduate Follow-up

Information on the subsequent behavior patterns for graduates was gathered through telephone interviews. A sample of twenty training institutions was randomly selected from among the 99 which responded to the supply questionnaire indicating that they were a supply source.

TABLE IX

PRESENT ENROLLMENT AND PROJECTED GRADUATE ESTIMATE FROM PUBLIC AND PRIVATE TRAINING INSTITUTIONS IN THE SINB REGION BY MAGNITUDE OF OUTPUT IN THE YEAR 1971

Training Program Title	Average Length Of Training (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates For the Calendar Years: 1971	1972-73	1974-75	Total
Radiologic Technology	23.8	1,441	668	992	1,054	2,714
Non-Destructive Testing	3.0	7	90	120	120	330
Radiological Health Technician	20.0	69	72	41	48	161
Nuclear Technology	18.0	90	63	124	120	307
Nuclear Medical Technology	16.4	65	53	117	143	313
Radiologic Technology (X-ray)	16.5	61	51	98	96	245
Radiography	4.0	24	30	90	90	210
Radiological Monitoring	3.0	20	20	20	20	60
Installation, Operation, and Maintenance of Reactors	3.0	15	15	48	48	111

TABLE IX (Continued)

Training Program Title	Average Length Of Training (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates For the Calendar Years: 1971	1972-73	1974-75	Total
Electronic Technology (Nuclear Option)	18.0	20	10	10	10	30
Radiation Therapy	19.3	16	8	13	18	39
Instrumentation Technology (Nuclear Option)	6.0			12	15	27
Electromechanical Technology (Nuclear Option)	24.0			6	12	18
Total		1,828	1,080	1,691	1,794	4,565

TABLE X

SUBSEQUENT BEHAVIOR OF GRADUATES OF THE YEAR 1970 FROM NUCLEAR TRAINING PROGRAMS FROM SELECTED PUBLIC AND PRIVATE SCHOOLS IN THE SINB REGION

Activity After Graduation	Numbers	Percent
Working full-time in the field of their training or related field	121	71.2
Working full-time in a field not related to the training	7	4.1
Continuing Education	16	9.4
Armed Forces	10	5.9
Unemployed	5	2.9
Status not known	11	6.5

Table X shows the response patterns of school officials regarding their graduates. In the year 1970, out of the 170 graduates from the reporting programs, 71.2 percent took jobs in the same field for which they were trained or in related fields. The armed forces claimed 5.9 percent and another 9.4 percent reportedly continued their education at other institutions. Only 4.1 percent could not or did not find jobs related to their training and 2.9 percent were unemployed at the time of this telephone survey. No information was available on 6.5 percent of the graduates.

Another important source of trained manpower supply is the in-house training by the industry. Table XI presents projected in-house training output of industry.

TABLE XI

PROJECTED IN-HOUSE TRAINING OUTPUT IN NUCLEAR RELATED INDUSTRIES IN THE SINB REGION FOR SELECTED YEARS

Years	Projected Number of Trainees for All Jobs
1971	800
1972-73	1,135
1974-75	1,243
Total	3,178

From Table XI it can be seen that industry is projected to train 3,178 technicians in the five year period from 1971 through 1975, which averages about 630 technicians per year.

Data presented in Tables VI, IX, and XI can be summarized as indicated in Table XII.

TABLE XII

PROJECTED NET MANPOWER REQUIREMENTS FOR THE PERIOD 1971-75

Technician Demand/Supply	1971-75	Yearly Average
Supply of technicians from school and hospitals	4,565	913
Supply of technicians from in-house training	3,178	629
Total Supply	7,743	1,542
Demand for Technicians	16,507	3,301
Net Demand	8,764	1,759

Table XII shows that, assuming all the graduates from schools and hospitals take jobs in the field of their training, there will be an average net demand of 1,759 nuclear related technicians per year. Detailed information on in-house training will be reported later in the chapter when manpower demand and supply are interfaced.

Worker Profiles

In order to further investigate the training patterns of nuclear manpower with specific implications for interfacing manpower supply and demand, a sample of workers from the employing organizations was selected to assess their educational and work experience background. Table XIII represents selected characteristics of 1,731 workers from eight different organizations who responded to the worker profile questionnaire. A marked difference was observed between the background or workers employed in health related jobs and those employed in non-health related jobs. Health related workers tended to be younger in age, have more formal training from a school or a hospital training program, have more experience in jobs related to their training than in other jobs. They also tended to have more than a high school education.

Non-health related worker, on the other hand, tended to be older (average age 39.6 years, as against 31.8 years for all workers), have almost all their training on-the-job or in-house, have more experience in jobs outside the field, rather than in the nuclear field (average of only 1.8 years). All the non-health related workers were male, whereas the majority of health related workers were female (68.9 percent).

TABLE XIII

SELECTED CHARACTERISTICS OF WORKERS EMPLOYED IN NUCLEAR RELATED JOBS

Description	Unit of Measure	All Workers					Non Medical Worker
		Arithmetic Mean	Range	Minimum	Maximum	Mode	Arithmetic Mean
Age	years	31.8	42.0	20.0	62	42	39.6
School/College Education	years	12.3	6.0	10.0	16	12	11.7
Training in Nuclear Field	months	15.8	48.0	0.0	48	24	7.5
Training in Other than Nuclear Field	months	3.9	48.0	0.0	48	16	6.6
Experience in Nuclear Related Jobs	years	2.9	21.5	0.5	22	1	1.8
Experience in Other than Nuclear Related Jobs	years	5.3	28.0	0.0	28	10	8.2

Most of the experience outside the nuclear field, as it relates to non-health related workers, has been reported in the field of power generation with most of the training obtained in the armed forces or on-the-job.

Interfacing of Manpower Supply and Demand

Interfacing of manpower supply and demand utilizes the cluster of jobs and training programs. The clusters of jobs may contain a number of jobs which are generally related to each other in such a way that a graduate from a specific training program can be placed on any of the jobs. Similarly, a number of training programs may be joined into a program cluster.

Table XIV, represents the interfacing of job clusters with program clusters representing manpower demand and supply respectively for the year 1971. The table shows a net manpower demand of 940 technicians in the "Power, Production and Related Jobs", "Testing, Monitoring and Related Jobs", and "Health Related Jobs" clusters. A further analysis of the information presented shows that the largest net demand is for testing and monitoring occupations.

No assessment of the supply for the jobs in the "Others" cluster was available because these jobs, though very important, are not peculiar to nuclear related industries. Supply for many of these may be available in sufficient quantity, but some of the jobs, like welding technicians, are specialized in nature and require extensive on-the-job training.

TABLE XIV

NET MANPOWER DEMAND OF EMPLOYING ORGANIZATIONS WITHIN THE SINB REGION FOR THE YEAR 1971

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY			Net Manpower Demand	CLUSTERS OF PROGRAMS
		Public and Private Schools	Hospitals*	In-House Training		
Power, Production and Related Jobs						
015.380 Test or Research Reactor Operator	44			127		
015.380 Production, Test or Research Reactor Operator-Government Owned	9			-		
015.181 Accelerator Operator	27			-		
015.380 Radioisotope-Production Operator	50			2		
1.05 Nuclear Power Plant Operator	69			15		
015.380 Hot-Cell Technician	14			-		

*When the reporting hospital is part of a university medical college, its data are included in "schools"

TABLE XIV (Continued)

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY: Public and Private Schools	SUPPLY: Hospitals*	SUPPLY: In-House Training	Net Manpower Demand	CLUSTERS OF PROGRAMS
<u>Power, Production and Related Jobs (Continued)</u>						
1.06 Nuclear Material Processor, Senior	5			–		
1.08 Nuclear Facility Equipment Operator	86			19		
1.09 Nuclear Facility Maintenance Technician	92			–		
		61	2			16.0115 Nuclear Technology
		15	–			17.2003 Installation, Operation and Maintenance of Reactors
TOTAL	396	76	2	163	155	

*When the reporting hospital is part of a university medical college, its data are included in "schools"

TABLE XIV (Continued)

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY: Public and Private Schools	SUPPLY: Hospitals*	SUPPLY: In-House Training	Net Manpower Demand	CLUSTERS OF PROGRAMS
<u>Testing, Monitoring and Related Jobs</u>						
199.187 Radiation Control Technician	142	20	-	30		16.9001 Radiological Monitoring
2.02 Nuclear Facility Chemistry (Radiochemistry) Technician	57			10		
2.03 Non-Destructive Testing Technician	325	90	-	154		16.9002 Non-Destructive Testing
828.281 Instrumentation and Control Technician	124	-	-	-		16.0119 Instrumentation Technology (Nuclear)
729.281 X-ray Calibration Technician	35	-	-	-		16.0199 Electromechanical Technology (Nuclear)
010.281 Well Logging Technician	477	10	-	4		16.0109 Electronics Technology (Nuclear)
TOTAL	1,160	120	-	198	842	

*When the reporting hospital is part of a university medical college, its data are included in "schools"

TABLE XIV (Continued)

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY			Net Manpower Demand	CLUSTERS OF PROGRAMS
		Public and Private Schools	Hospitals*	In-House Training		
<u>Health Related Jobs</u>						
078.368 Radiologic Technologist	761	263	402	210		07.0501 Radiologic Technology
078.168 Radiologic Technologist, Chief	121	50	1	125		16.0304 Radiologic Tech. (X-ray)
078.381 Nuclear Medical Technologist	233	–	53	84		07.0503 Nuclear Medical Technology
4.04 Chest Radiographer	20	30	–	–		17.2002 Radiography
4.05 Urology X-ray Technician	18	–	–	–		
4.06 Orthopedic Radiologic Technician	40	–	–	–		
4.07 Special Procedures Technician	89	–	–	–		
4.08 Radiation Therapy Technician	101	5	3	16		07.0502 Radiation Therapy
4.09 Internal Dosimetry Technician	5	–	–	–		

*When the reporting hospital is part of a university medical college, its data are included in "schools"

TABLE XIV (Continued)

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY: Public and Private Schools	SUPPLY: Hospitals*	SUPPLY: In-House Training	Net Manpower Demand	CLUSTERS OF PROGRAMS
Health Related Jobs (Continued)						
078.368 Radiobiology Technician	26	72	-	-		07.0902 Radiological Health Tech.
4.11 Radiopharmacist	13	-	-	-		
TOTAL	1,427	420	459	435	113	
Jobs for Which Supply was not Assessed						
040.281 Soils Evaluation Technician	418	-	-	-		
015.281 Draftsman	214	-	-	-		
020.188 Computer Programmer	64	-	-	-		
007.281 Mechanical and Structural Technician	265	-	-	-		
011.281 Welding Technician	87	-	-	-		
003.281 Electronic and Instrument Technician	252	-	-	-		

*When the reporting hospital is part of a university medical college, its data are included in "schools"

TABLE XIV (Continued)

CLUSTERS OF OCCUPATIONS	DEMAND	SUPPLY: Public and Private Schools	SUPPLY: Hospitals*	SUPPLY: In-House Training	Net Manpower Demand	CLUSTERS OF PROGRAMS
<u>Jobs for Which Supply was not Assessed (Continued)</u>						
019.281 Quality Control and/or Quality Assurance Specialist	137	-	-	-		
TOTAL	1,437	-	-	-		

*When the reporting hospital is part of a university medical college, its data are included in "schools"

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary purpose of this study has been to analyze subprofessional manpower supply and demand in nuclear related industries. A total of 418 employing organizations which hire subprofessional nuclear related manpower and 99 institutions which train nuclear related manpower were surveyed. Data pertaining to demand and supply and their analysis have been presented in the preceding chapter. This chapter will be concerned with relating that analysis to specific findings, conclusions and recommendations.

Findings

Findings, as they relate to the research questions posed in Chapter I, are presented as follows:

Research Question One

What is the magnitude of present employment at the subprofessional level in nuclear related industries by job title and type of industry within the SINB region?

Findings

1. Total present employment was reported at 8,547, of which about 25 percent each is accounted for by the "Testing, Monitoring and Related

Jobs", and the "Health Related Jobs" clusters.

2. The "Power, Production and Related Jobs" cluster which contains reactor operators, processors and nuclear maintenance technicians employs only 17.9 percent of all jobs.

Research Question Two

What is the estimated demand, both present and future, of nuclear related industries for subprofessional manpower within the SINB region?

Findings

3. Total demand for 1971 was estimated at 4,420. For the period 1971 through 1975 the demand has been estimated at 16,507, whereas, the projected demand for the period 1971 through 1980 is 24,464.

Research Question Three

What training programs exist in the SINB region that attempt to meet the needs of nuclear related manpower?

Findings

4. There are 99 institutions which train technicians offering 137 training programs. Descriptions of these training programs can be seen in Appendix G. The top three training programs in terms of 1971 graduate output are radiologic technology, non-destructive testing and radiologic health technology.

5. Employing organizations have a large number of in-house training programs, and they account for 56.8 percent of the total training programs identified in this study. A total of 130 employing

organizations offer 180 training programs to train workers for specific jobs in their own establishments.

Research Question Four

What is the present supply and future potential supply of graduates from existing training programs within the SINB region?

Findings

6. The 99 training institutions are projected to supply 1,080 graduates in 1971. During the five year period, 1971 through 1975, the number estimated is 4,565 to graduate.

7. Employing organizations are projected to train 800 technicians during 1971. During 1971-1975, these organizations have projected to train 3,178 technicians.

Research Question Five

What are some of the subsequent employment patterns of graduates from existing training programs?

Findings

8. Most of the graduates (71.2 percent) from training programs tend to find jobs within the field of their training or in related fields. The other 28.8 percent are claimed by jobs in non-related fields, continuing education activities, armed forces, and those who are unemployed.

9. The percentage of graduates finding jobs in the field of training is slightly higher in health related training programs than in others.

10. Employing organizations train workers for specific jobs only and therefore, are expected to utilize all their training output.

Research Question Six

What are the major characteristics of subprofessional workers presently employed in nuclear related industries that affect the interfacing of manpower demand and supply?

Findings

11. Workers have, in general, a high school education; they have an average of 15.8 months of training in a training program related to their present job, they have an average of 8.2 years of work experience of which only 2.9 years' is related to the jobs in the nuclear field.

12. Workers are predominantly male except in health realted jobs where females predominate with 68.9 percent of the total.

13. In non-health related jobs, the workers are older, they have training of a shorter duration and have less experience on nuclear related jobs than do technical workers in the "Health Related Jobs" cluster. Furthermore, most of their experience (an average of 8.2 years) is in fossil fueled power plants or in the armed forces.

14. Workers are not very mobile and tend to take jobs near the places where they completed their training.

15. On an average, a worker has held 3.6 jobs including his present employment.

Research Question Seven

What training program changes will be necessary to adequately meet the subprofessional manpower needs of nuclear related industries within the SINB region?

Findings

16. In 1971 there will be a net demand for 940 jobs. The present levels of supply within the region will be inadequate to meet this net demand.

17. The largest net demand is for jobs in the "Testing, Monitoring and Related Jobs" cluster.

18. Most of the employers indicate that they will hire the graduates from training institutions providing the quantity and quality of training is commensurate with their needs.

19. Only a small number of employing organizations indicate that they will continue to train their own workers and will not hire from schools' training programs.

20. Most institutions "Project" expanding training programs but at a slower rate than the increase in demand.

Conclusions

The following conclusions are based on the data collected and analyzed as well as the review of literature. When the review of literature is utilized as a source for drawing a conclusion, it will be so designated.

1. Training institutions within the SINB region have not kept pace with the increase in demand for nuclear related manpower. This is the

case notwithstanding the fact that employing organizations are willing to hire the graduates from the training institutions provided they are available in sufficient numbers and are of suitable quality.

2. From the apparent success of training institutions in placing their graduates in training related jobs, it can be concluded that the content of training is commensurate, at least within the scope of these programs, with the needs of industry. The major problem seems to be the initiation of new programs and expansion of existing ones in order to better satisfy net manpower requirements.

3. Training institutions tend to offer two-year-post-high-school programs only, leaving programs of less than two years duration to industry. This practice is not commensurate with the stated mission of the majority of these institutions. Private schools which are flexible in their program offerings and durations have not yet "discovered" nuclear training profitable to offer.

4. The present information sources, particularly those within the Federal Government, do not respond quickly to the new and emerging fields. The Dictionary of Occupational Titles does not list many of the jobs which have emerged due to new uses of nuclear energy. The Standard Industrial Classification, and the Occupational Outlook Handbook suffer from a similar lack of "sensitivity" to change.

5. From the review of literature and from the many associations with employing organizations and training institutions encountered during this study, the need for more systematic and continuous information sources was brought into sharp focus.

6. The "other jobs" cluster indicated the need for nuclear options in selected program areas, but the supply could not be determined

because of the specialized nature of this investigation. More specifically, it is possible to accurately determine the demand and supply for those occupations which are "inclusive" to the nuclear industry but not those which are commonly found in several employment sectors of the economy.

7. No employing organizations showed undue concern about the confidentiality of the manpower information requested from them. However, a small number refused to provide information related to worker profiles because of tight work schedules. This success was due, in part, to the utilization of "keymen" in hundreds of employing organizations who "understood" the need for such a study.

Recommendations

Recommendations discussed below are based not only on the findings of this study but also on the experiences gathered through different meetings with the SINB officials, Steering Committee members, Employer representatives and training institution officials.

Recommendations Related to Improvement of Information

1. Information is basic to any improvement in the program mix [distribution of training programs and related resources] of the training institutions. This information should be specific and current so as to be useful for program planning. It is, therefore, recommended that the survey results be updated at regular intervals both to make them current and to continuously enlarge their scope by including more training and employing organizations.

2. Although many researchers are confident of data obtained, employer surveys are criticized because the person answering the questionnaire is not always knowledgeable about manpower projections or is simply not concerned. It is recommended that the data from this study be interfaced with national trend data, where available, and suitable adjustments be made for long range educational planning.

3. The clusters of jobs and training programs utilized for interfacing in this study must be continuously refined. It is recommended that cycling of the system be done on a yearly basis so as to incorporate methodological improvements and more information about specific nuclear related jobs and training programs.

4. Schools and other training institutions must increase the flexibility in their program offerings. If some of the "short duration programs" can be offered in the schools, some of the resources, presently being used for training by industry, can be diverted to further development, thus creating new and more job opportunities. Accurate information about and close liaison between the schools and industry are essential for the achievement of this objective. It is recommended that an interagency manpower development committee be established in the SINB region so as to provide these services. Employers, schools and other institutions, state employment services, U.S.A.E.C. and other relevant agencies should be represented on this committee.

Recommendations Related to Further Research

1. Time lag between the emergence of a new technique or a job and the initiation of a training program to supply manpower for the job can

be considerably reduced by occupational analysis. This tool is extensively utilized by industry but very little by the educators. It is recommended that detailed occupational analysis be conducted on a representative sample of subprofessional jobs in the nuclear industry. This analysis should be conducted with specific implications of development or improvement of training programs. This often takes the form of curricular guides.

2. Although employing organizations stated their willingness to hire public school graduates, programs cannot be initiated unless their effectiveness is demonstrated. It is recommended that thorough research be conducted on cost and benefits of existing training programs both in the public and private sectors. Cost/benefit studies of proposed programs is also recommended.

3. A longitudinal follow-up study of the graduates from training programs is recommended with implications for improving curriculum design.

4. A feasibility study for cooperative training programs offered jointly by the schools and industry is recommended for possible implementation in the SINB region. This may be particularly important in programs requiring less than a two-year-post-high school time frame.

Matching of manpower supply and demand is one of the tools most often used by manpower decision and policy makers. The effectiveness of this tool, however, is limited to the extent of availability and use of relevant data. Survey research, such as the one reported in the preceding chapters, can provide the technique to collect, analyze, and disseminate data relevant to manpower planning. The significance of such research is underscored by the need for trained manpower in the country. The results of the survey will be useful both for the educators as well as the employers in the field of nuclear technology.

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APPENDIX A

LIST OF MEMBERS OF THE SOUTHERN INTERSTATE NUCLEAR BOARD

LIST OF MEMBERS OF THE SOUTHERN INTERSTATE NUCLEAR BOARD

Alabama

Arkansas

Delaware

Florida

Georgia

Kentucky

Louisiana

Maryland

Mississippi

Missouri

North Carolina

Oklahoma

Puerto Rico

South Carolina

Tennessee

Texas

Virginia

West Virginia

APPENDIX B

MEMBERS OF ADVISORY COMMITTEE

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Phone: (803) 782-5471

Dr. John C. Shearer
Professor of Economics and Director
Manpower Research & Training Center
College of Business Administration
Oklahoma State University
Stillwater, Oklahoma 74074
Phone: (405) 372-6211, ext. 258

February 9, 1971

APPENDIX C

"KEYMAN" LETTER AND REPLY-PAID
POSTCARD

SAMPLE "KEY MAN" LETTER

Telephone (404) 876-4385

SOUTHERN INTERSTATE NUCLEAR BOARD Suite 664 • 800 Peachtree St NE • Atlanta, Ga. 30308

October 29, 1970

Mr. John A. Hancock
Senior Nuclear Engineer
Florida Power Corporation
Post Office Box 14042
St. Petersburg, Florida 33733

Dear Mr. Hancock:

One function of the Southern Interstate Nuclear Board is to assist you in achieving your objectives by supporting programs to upgrade the technical manpower supply in the region. Because the rapid growth of the nuclear industry foretells increased job opportunities for trained technicians below the baccalaureate level, the Board at its Ninth Annual Meeting last April approved a project for a systematic approach to nuclear technician manpower planning throughout the region.

Specifically, answers will be sought to such questions as: (a) Who needs and will need nuclear technicians? (b) What skills and training are required? (c) Where will they be needed? (d) When will they be needed and in what numbers? (e) How can vocational and technical education facilities meet the needs?

Your organization has been identified as holding a license for use of nuclear materials and, therefore, as one which may have a present, or future need for trained nuclear technicians. To properly carry out this manpower research project, we will:

1. Send you a questionnaire related to your present and future nuclear technician manpower needs, and

2. Send you a final report which will hopefully contain answers to questions stated at (a) thru (e) above.

We would hope that as a result of this effort a systematic and continuous procedure to insure a more rational development in this manpower field could be devised.

Accordingly, we would appreciate it if you would identify a key man from your organization who is most familiar with nuclear technician manpower and training requirements and with whom we can communicate about this matter. We hope to mail questionnaires in November, 1970, and complete the final report by June 30, 1971. Therefore, we would also appreciate your completing and returning the enclosed addressed, postage prepaid card at your earliest convenience.

Dr. Paul Braden and associates from Oklahoma State University, who recently completed Oklahoma's Occupational Training Information System (OTIS), will assist the SINB in all phases of this study.

Sincerely,

Robert H. Gifford
Executive Director

RHG:bhe

Enclosures

SOUTHERN INTERSTATE NUCLEAR BOARD
NUCLEAR TECHNICIAN MANPOWER & TRAINING PROJECT

ORGANIZATION

ADDRESS

CITY - STATE - ZIP CODE

NAME OF KEY MAN TO WORK WITH THIS PROJECT

TITLE

PHONE NUMBER

PLEASE RETURN AS SOON AS POSSIBLE.

First Class
Permit No. 6807
Atlanta, Georgia

BUSINESS REPLY MAIL No postage stamp necessary if mailed in the United States

Postage will be paid by

Southern Interstate Nuclear Board
Suite 664
800 Peachtree Street, N.E.
Atlanta, Georgia 30308

APPENDIX D

FORWARDING LETTERS WITH DEMAND AND SUPPLY QUESTIONNAIRES

Telephone (404) 876-4385

SOUTHERN INTERSTATE NUCLEAR BOARD Suite 664 • 800 Peachtree St NE • Atlanta, Ga. 30308

You were designated by your organization recently as the "key person" most familiar with present and future manpower and training requirements for personnel in the nuclear field whose duties are generally at the technician level. Accordingly, would you please fill out the attached questionnaire and return it in the enclosed postage paid envelope? This demand data will be compared with supply information from a related study of training institutions.

The form is designed to determine technician manpower needs for each establishment or division of your organization (if more than one) within the SINB Region. This includes Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, West Virginia and the Commonwealth of Puerto Rico.

A steering committee of persons whose names appear on the attached list has carefully reviewed the questionnaire, and believes that the information obtained will be vital to your interests; particularly by assisting training institutions in their efforts to provide trained persons to meet your manpower requirements. You will receive a summary of the final report which should be available in July, 1971. So that we can meet this date, we would appreciate your returning the questionnaire by December 21, 1970.

Please be assured that the information you furnish will be held in strict confidence and only this Board and selected school officials will share it. If you have any questions or would like additional information, please feel free to phone or write.

Sincerely,

Robert H. Gifford
Executive Director

RHG:bhe

Enclosures

Telephone (404) 876-4385

SOUTHERN INTERSTATE NUCLEAR BOARD Suite 664 • 800 Peachtree St NE • Atlanta, Ga. 30308

MEMORANDUM

TO: Firms, Organizations, and Agencies Holding Licenses for Use of Nuclear Materials

FROM: Robert H. Gifford, Executive Director

SUBJECT: Nuclear Technician Manpower Research Project

DATE: December 1, 1970

We wrote you recently to explain a project to assist in bringing about a more systematic approach to nuclear technician manpower planning which is being undertaken by the Southern Interstate Nuclear Board. In that letter we requested that you furnish us the name of a "key man" from your organization who is familiar with your manpower and training needs and with whom we could communicate about this matter.

We have not heard from you, so perhaps you did not have and/or did not anticipate any requirements for nuclear technicians. Or, maybe the letter got buried and was overlooked in the press of business. If the latter was the case, we would appreciate your filling out the attached questionnaire and returning it in the enclosed postage-paid envelope by December 31, 1970.

A select steering committee of persons whose names appear on the attached list has carefully reviewed the questionnaire, and believe that the information obtained will be vital to your interests; particularly by assisting training institutions in their efforts to provide trained persons to meet your manpower requirements.

Please be assured that the information you furnish will be held in strict confidence and only this Board and selected school officials will share it. You will receive a summary of the final report which should be available in July, 1971.

If you have any questions or would like additional information, please feel free to phone or write.

Enclosures

APPENDIX E

REMINDERS TO NON-RESPONDENTS

Telephone (404) 876-4385

SOUTHERN INTERSTATE NUCLEAR BOARD Suite 664 • 800 Peachtree St NE • Atlanta, Ga. 30308

We have found that because of unexplained reasons questionnaires sent to previously-designated "key person" contacts within certain organizational groups in the South have not received these forms mailed from this office in late November. Accordingly, we are again making full distribution of the questionnaires.

If you have received and completed the attached instrument, please disregard this one. If not, we would greatly appreciate your filling it in and returning it to us at your earliest convenience.

For informational purposes, we have included a copy of the original letter sent with the questionnaire on the initial mailing.

Sincerely,

Robert H. Gifford
Executive Director

RHG:bhe

Enclosures

SERVING THE STATES OF THE SOUTHERN GOVERNORS' CONFERENCE

Nuclear Technician Manpower Project
Southern Interstate Nuclear Board
Suite 664, 800 Peachtree St., N.E.
Atlanta, Georgia 30308

Dear Sir:

You recently received a questionnaire requesting information relating to nuclear manpower. December was set as the target date for returning the completed form. We know this is a busy time of year; however, would you please take a few minutes now to complete and mail the questionnaire or advise us if it has no applicability for your organization. If by chance you have misplaced the questionnaire or have any questions relating to the project, please call Robert Gifford, SINB Exec. Dir. at (404) 876-4385. Thank you for your assistance.

January 4, 1971

APPENDIX F

DEMAND QUESTIONNAIRE

DEMAND QUESTIONNAIRE

1. NAME OF THE ESTABLISHMENT ____

____

(If the establishment is a part of another organization, specify the name of the organization but report only the establishment named above. A separate questionnaire should be completed for each of your establishments within the SINB region. Please make extra copies where necessary.)

2. MAILING ADDRESS OF ESTABLISHMENT ______________________________
Number and Street

____
City or Town | State | County | Zip Code

3. ____
Representative Completing This Form

____
Representitive's Title

____
Representative's Address

____
Representative's Phone and Extension

4. TOTAL NUMBER OF EMPLOYEES IN THIS ESTABLISHMENT ____________

Please rank the segment(s) of the nuclear field in which this establishment participates using product or service "mix" activity as a guideline. Please rank them (1) for the most and (2), (3), (4), etc. for the next highest level of activity.

____ Uranium Milling

____ Production of Feed Materials

____ Production of Special Materials for Use in Reactors

____ Fuel Element Fabrication and Recovery Activities

____ Reactor and Reactor Component Design and Manufacturing

____ Radiation Preservation of Foods

____ Radioactive Waste Disposal

____ Activation Analysis

____ Nuclear Instrument Manufacturing

____ Processing and Packaging Radioisotopes

____ Particle Accelerate Manufacturing

____ Research Laboratories

____ Design and Engineering of Nuclear Facilities

____ Power Reactor Operation and Maintenance

____ Uranium Mining

____ Radiation Processing

____ Irradiation Manufacturing or Services

____ Non-Destructive Testing (NDT)

____ Transportation of Radioactive Materials

____ Industrial Radiography

____ Nuclear Medicine

____ Other Health Related

____ Nuclear Training for Employment Outside your Organization

____ Higher Education

____ Other ____________________
(Please Specify)

GENERAL INSTRUCTIONS

■ Please enter your best estimates of the number of workers you will need for the "job titles and descriptions" and "years" listed on the following pages. When estimating manpower requirements only consider "new jobs" and "replacements" (deaths, retirements, and normal turnover) and enter the composite figure in the appropriate column.

■ When estimating your manpower needs, please enter your total anticipated requirements even though you may plan to satisfy a portion and/or all of this through training programs within your own organization.

■ When estimating manpower requirements for more than one calendar year, please enter only the cumulative total requirements for new jobs and replacements. For example, if you estimate your need for a specific job title to be 3 in 1972 and 4 in 1973, enter only the total of 7 in the column headed 1972-73.

■ If you cannot relate the work performed in your establishment to the descriptions contained herein, list your own job title and a description of the work performed on the blank spaces provided for that purpose. If you need more space than provided please use an extra blank sheet.

ASSUMPTIONS--These manpower estimates should be based on the assumptions (1) that the economic growth rates over the past decade of your establishment and/or organization and the state and national economy will continue their trend unless you anticipate changes, (2) that private and government support of nuclear and nuclear related activities will continue at the same fraction of the GNP, and (3) that required manpower will be available.

Job Code	Job Titles and Descriptions for Reactor Operation and Production Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
1.01	TEST OR RESEARCH REACTOR OPERATOR--Performs hands-on operation of these facilities and requires AEC Senior Reactor Operator or Reactor Operator License.					
1.02	PRODUCTION, TEST OR RESEARCH REACTOR OPERATOR-GOVERNMENT OWNED--Performs hands-on operation of these facilities and requires certification by the operating agency.					
1.03	ACCELERATOR OPERATOR--Sets up or assists in setting up, coordinates, and monitors the operation of particle accelerates under the supervision of a research scientist.					
1.04	RADIOISOTOPE-PRODUCTION OPERATOR--Prepares radioisotopes and other radioactive materials for use in biological, biochemical, physiological, and industrial research.					
1.05	NUCLEAR POWER PLANT OPERATOR--Performs hands-on operation of the nuclear power plant requiring AEC Senior Reactor Operator of Reactor Operator License.					
1.06	NUCLEAR MATERIAL PROCESSOR, SENIOR--Is responsible for the maintenance and operation of radioactive processing facilities; receiving, transferring, and shipping of nuclear material, and the issuance of reactor fuels for research assemblies.					
1.07	HOT-CELL TECHNICIAN--Operates remote-controlled equipment in cell to perform chemical and metalurgical tests involving radioactive materials.					
1.08	NUCLEAR FACILITY EQUIPMENT OPERATOR--Operates nuclear facility auxiliary equipment and does not require AEC operator license.					

Job Code	Job Titles and Descriptions for Reactor Operation and Production Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
1.09	NUCLEAR FACILITY MAINTENANCE TECHNICIAN--Performs electrical and mechanical equipment maintenance on nuclear facility.					
Other--Please Describe						
Other--Please Describe						

Job Code	Job Titles and Descriptions for Test and Measurement Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
2.01	RADIATION CONTROL TECHNICIAN--Monitors personnel, plant facilities, work environment, and plant vicinity to detect and control radioactivity and/or radiation exposure. Performs operation, analysis and calibration of radiation monitoring equipment.					
2.02	NUCLEAR FACILITY CHEMISTRY (RADIOCHEMISTRY) TECHNICIAN--Performs all plant related laboratory chemistry analyses including radiochemistry.					
2.03	NON-DESTRUCTIVE TESTING TECHNICIAN--Performs NDT testing on nuclear facility equipment (includes radiography, ultrasonics, dye penefram, magnetic particle and visual techniques.					
Other--Please Describe						
Other--Please Describe						

Job Code	Job Titles and Descriptions for Instrumentation Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
3.01	INSTRUMENTATION AND CONTROL TECHNICIAN--Handles facility instrumentation and control system calibration and maintenance. (Includes computer maintenance)					
3.02	X-RAY CALIBRATION TECHNICIAN--Test X-ray calibration, equipment reliability and safety; evaluates field and filter performance.					
3.03	WELL LOGGING TECHNICIAN--Conducts radioactive logging in the underground study of oil fields; maintains source instruments; evaluates data.					
Other--Please Describe						
Other--Please Describe						

Job Code	Job Titles and Descriptions for Health Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
4.01	RADIOLOGIC TECHNOLOGIST--Applies roentgen and/or gamma rays to patients for diagnostic and therapeutic purposes.					
4.02	RADIOLOGIC TECHNOLOGIST, CHIEF--Coordinates activities of and supervises radiologic technologists engaged in taking and developing X-ray photographs.					
4.03	NUCLEAR MEDICAL TECHNOLOGIST--Prepares, administers and measures radioactive isotopes in therapeutic, diagnostic, and tracer applications, utilizing variety of radioactive equipment.					
4.04	CHEST RADIOGRAPHER--Conducts mass chest X-ray surveys to determine the incidence of pulmonary diseases.					

Job Code	Job Titles and Descriptions for Health Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years: 1971	1972-73	1974-75	1976-80
4.05	<u>UROLOGY X-RAY TECHNICIAN</u>--Assists a urologist by performing radiographic examinations of the urogenital tract to rule out disease in that system.					
4.06	<u>ORTHOPEDIC RADIOLOGIC TECHNICIAN</u>--Works with an orthopedic surgeon in performing radiographic studies of the skeletal system.					
4.07	<u>SPECIAL PROCEDURES TECHNICIAN</u>--Performs radiographic studies of the blood vessels and the nervous system, which requires special skills.					
4.08	<u>RADIATION THERAPY TECHNICIAN</u>--Positions patients and applies X-ray or gamma radiation to predetermined anatomical areas with known malignant disease.					
4.09	<u>INTERNAL DOSIMETRY TECHNICIAN</u>--Conducts whole body counting, bioassay, and wound contamination analysis.					
4.10	<u>RADIOBIOLOGY TECHNICIAN</u>--Conducts tests for external and internal radiation effects in plants and animals.					
4.11	<u>RADIOPHARMACIST</u>--Purchases of pre-prepared radiopharmaceuticals and formulates all locally prepared radiopharmaceutical compounds.					
Other--Please Describe						
Other--Please Describe						
Other--Please Describe						

Job Code	Job Titles and Descriptions for Related Technicians	How many technician level workers are presently employed?	Estimated Manpower Requirements for the Calendar Years:			
			1971	1972-73	1974-75	1976-80
5.01	SOILS EVALUATION TECHNICIAN--Assesses soil density, radioactivity, and moisture content.					
5.02	DRAFTSMAN--Performs routine tasks in preparing detail engineering drawings, from work outlined by others.					
5.03	COMPUTER PROGRAMMER--Converts scientific, engineering, and other technical problem formulations to a format processed by computer.					
5.04	MECHANICAL AND STRUCTURAL TECHNICIAN--Assists in the design and fabrication of nuclear facility mechanical and structural equipment.					
5.05	WELDING TECHNICIAN--Performs specialized welding operations on nuclear components--requires code certification.					
5.06	ELECTRONIC AND INSTRUMENT TECHNICIAN--Does various operations connected with fabricating, assembling, modifying, maintaining, and installing nuclear electronic equipment.					
5.07	QUALITY CONTROL AND/OR QUALITY ASSURANCE SPECIALIST--Does product evaluation, testing, and monitoring to insure strict adherence to product specifications.					
Other--Please Describe						
Other--Please Describe						

TRAINING PROGRAMS

1. Do you have an in-house or on-the-job training program? YES ____ NO ____
(check one)

2. If yes, please supply the following information.

Job Title(s) for Which You Have Training Programs	Length of Training Program in Hours	Number of Graduates (if any) in the Years: 1971	1972-73	1974-75	1976-80

All other things being equal, would you hire graduates from public and private training institutions if they were available for the job titles listed above? YES ____ NO ____
(check one)

If no, please explain: ____

____

____

____

APPENDIX G

SUPPLY QUESTIONNAIRE

NUCLEAR MANPOWER INFORMATION SYSTEM

1. ____
Name of the representative completing the questionnaire

____
Representative's title

____
Representative's phone number and extension

2. ____
Name of the institution and/or organization

____
Number and Street

____
City or Town   State   Zip Code

3. Is this institution or organization (check one):

____ University

____ Technical Institute

____ Four Year College

____ Junior and/or Community College

____ Area Vocational School

____ Private Vocational School

____ Hospital

____ Training School operated by an industry for purposes other than training their own labor supply

____ Other ______________________
(Please Specify)

GENERAL INSTRUCTIONS

■ Please enter your best estimate of the number of nuclear related manpower program graduates for the "program descriptions" and "years" listed on the following pages. Space is provided for you to list any additional program descriptions.

■ Provide information on nuclear related training program graduates which generally have the following characteristics:

1. The program is usually offered beyond the "secondary" but less than the "baccalaureate level".
2. The content is derived from technical skills and knowledge requirements of technical occupations.
3. Mathematics and the physical or biological sciences are integral parts of the program; technical study is mathematics and science-based at all levels of the program.
4. The technical specialization is within an occupational field; but is not confined to, or limited by, the requirements of any single occupation or industry. The emphasis in instruction is placed on technical skills and knowledge that have broad applications.
5. Instruction is laboratory-oriented and makes use of many applications of the technical principles being studied. Emphasis is placed on analytical, rational thought processes in addition to the development of specific procedural techniques or skills.

ASSUMPTIONS—These estimates should be based on the assumptions (1) that the economic growth rates over the past decade of your training operations and/or organization and the state and national economies will continue their trend unless you anticipate changes, and (2) that private and government support of nuclear and nuclear related activities will continue at the same fraction of the Gross National Product.

Program Code	Titles and Descriptions	Duration of Program (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates for the Calendar Years:			
				1970	1971	1972-73	1974-75
07.0501 (As Modified)	RADIOLOGIC TECHNOLOGY--A combination of subject matter and experiences designed to prepare a person for the safe use of X-ray and/or other radiation equipment in clinical settings under the supervision of a radiologist or other physician.						
07.0502	RADIATION THERAPY--A combination of subject matter and experiences designed to prepare a person to use radiation producing devices to administer therapeutic treatments as prescribed by a radiologist.						
07.0503	NUCLEAR MEDICAL TECHNOLOGY--A combination of subject matter and experiences designed to enable a person to prepare, administer, and measure radioactive isotopes in therapeutic, diagnostic, and tracer studies, utilizing a variety of radioisotope equipment.						
07.0902 (As Modified)	RADIOLOGICAL HEALTH TECHNICIAN--A combination of subject matter and experiences designed to prepare a person to conduct radiological measurements and evaluations of exposure to X-ray, gamma, and alpha emitters and to recommend measures to insure maximum protection.						
16.0115 (As Modified)	NUCLEAR TECHNOLOGY--The subject matter emphasizes atomic and nuclear physics, nuclear reactor physics, nuclear reactor operations, health physics, shielding radioisotopes, chemistry, electronics, nuclear instrumentation and nuclear reactor safety.						

Program Code	Titles and Descriptions	Duration of Program (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates for the Calendar Years: 1970	1971	1972-73	1974-75
16.0304	<u>RADIOLOGIC TECHNOLOGY (X-RAY)</u>--A combination of subject matter and experiences designed to enable a person to prepare, administer, and measure radioactive isotopes in therapeutic, diagnostic studies, utilizing a variety of radioisotope equipment.						
17.2001	<u>INSTALLATION, OPERATION, AND MAINTENANCE OF REACTORS</u>--Organized learning experiences concerned with atomic reactor plants, their use, and related factors.						
17.2002	<u>RADIOGRAPHY</u>--Organized learning experiences concerned with the installation, safe operation, interpretation, and maintenance of industrial X-ray equipment.						
17.2003	<u>INDUSTRIAL USES OF RADIOISOTOPES</u>--Organized learning experiences concerned with the industrial use of radioisotopes in production and control operations.						
Program Titles and Descriptions not Previously listed:							
Other--Please Specify Both the Title and Description							
Other--Please Specify Both the Title and Description							

NOTE: The program titles and descriptions listed below do not refer to nuclear programs as such, but rather to program areas that combine training in the nuclear field with training in a different area of specialization.

Program Code	Titles and Descriptions of Training Programs with a Nuclear Option	Duration of Program (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates for the Calendar Years: 1970	1971	1972-73	1974-75
16.0108 (As Modified)	ELECTRONIC TECHNOLOGY (NUCLEAR OPTION)--A combination of subject matter and experiences designed to prepare a person in fabricating, assembling, modifying and installing electronic equipment with some additional training in the nuclear field.						
16.0109 (As Modified)	ELECTROMECHANICAL TECHNOLOGY (NUCLEAR OPTION)--Specialized classroom and laboratory learning experiences in both the mechanical and electrical fields. Instruction is planned to provide preparation for responsibilities concerned with the design, development, and testing of electromechanical devices and systems within the nuclear field.						
16.0105 (As Modified)	CHEMICAL TECHNOLOGY (NUCLEAR OPTION)--The subject matter emphasizes qualitative, quantitative and analytical analysis in general and organic chemistry. This program prepares the graduate to install, and operate pilot plants for chemical processes, and may be directly involved with the preparation of isotopes and other radioactive materials.						
16.0112 (As Modified)	INSTRUMENTATION TECHNOLOGY (NUCLEAR OPTION)--This program is planned to prepare the graduate to design, develop prototypes, test and evaluate control systems or automated systems, and prepare written reports in support of professional personnel. This program is concerned with the instrumentation within the nuclear field.						

NOTE: Use the spaces below for program titles and descriptions with a nuclear option which were not listed previously

Program Code	Titles and Descriptions Training programs with some emphasis in the Nuclear Field--Not Previously Listed	Duration of Program (In Months)	Present Enrollment (If Any)	Estimated Number of Graduates for the Calendar Years:			
				1970	1971	1972-73	1974-75
Other--Please Specify Both the Title and Description							
Other--Please Specify Both the Title and Description							
Other--Please Specify Both the Title and Description							
Other--Please Specify Both the Title and Description							

APPENDIX H

WORKER CHARACTERISTICS QUESTIONNAIRE

NUCLEAR TECHNICIAN MANPOWER SURVEY

TO: Employees in Nuclear Related Technician Jobs

FROM: Robert H. Gifford, Executive Director, Southern Interstate Nuclear Board

Your organization is co-operating in a study of nuclear related manpower supply and demand in 17 southern states and Puerto Rico. Please complete this form and return to your supervisor. This information will be held confidential.

1. Technician Identification ______________________________
(name optional)

2. Job Title ______________________________
(For example: Reactor Operator or Instrument Technician)

3. Present Age ____ 4. Sex /M/ /F/ (check one)

5. Please mark an "X" for the highest school year you have completed.

High School: /_/ 9 or less /_/ 10 /_/ 11 /_/ 12

College: /_/ 1 /_/ 2 /_/ 3 /_/ 4 /_/ 5 /_/ 6

6. Please list all specific training or education in the chart below. (First two lines are examples only.)

	Name of Training or Education Program: Include Programs Offered by Industries	Length of Training In Months	Location of Institution or Organization	Degree, Diploma, Or Certificate (Please specify)
Example	Welding	3	Smith Nuclear Power, Inc. (address)	Certificate of Completion
Example	X-Ray Technology	24	Smith Community College, Los Angeles, California	Associate Degree

7. **Total years of work experience** ____________
(Years)

8. **Years worked in nuclear related jobs. (Please specify job title (s) and years.)**
(a) ______________________________ ____________
(job title) (years)
(b) ______________________________ ____________
(job title) (years)
(c) ______________________________ ____________
(job title) (years)

APPENDIX I

FORWARDING LETTER WITH WORKER CHARACTERISTICS QUESTIONNAIRE

Telephone (404) 876-4385

SOUTHERN INTERSTATE NUCLEAR BOARD Suite 664 • 800 Peachtree St NE • Atlanta, Ga. 30308

March 29, 1971

Mr. John W. Stoute
Chief N.D.T.
Barrow-Agee Laboratories, Inc.
1400 Gaines Street
Little Rock, Arkansas 72201

Dear Mr. Stoute:

Thank you for assisting in the nuclear technician project by returning the completed nuclear technician manpower demand questionnaire, a copy of which is enclosed. This information is presently being analyzed from all respondents within 17 Southern states and Puerto Rico, and preliminary findings indicate up to a 300 percent increase in the demand for nuclear technicians in the 70's over present employment levels. This preliminary analysis foretells a very real need for further information on the background of those now holding nuclear technician related jobs. This information will assist us in the final phases of our study. Based on the background data developed, we may wish to discuss this with you personally at a later date. You will, of course, be provided with complete reports on all phases of the study and invited to attend a conference, planned for the Spring of 1972, on the final results of this effort, a task analysis and related supporting activities.

Your organization has been selected along with 19 others to participate in this background study. We hope you will assist us in this step by having the enclosed brief questionnaire completed either by the employee or from your records, whichever is most convenient. Please mail the questionnaire and/or necessary information (computer output) in the enclosed envelope. We would like to have your reply by April 15, 1971.

Should you have any questions, please contact Dr. Paul Braden or Mr. Krishan Paul, the Project Systems Analyst, at Oklahoma State University, Stillwater, Oklahoma (Telephone: 405, 372-6211). Your continued cooperation is greatly appreciated.

Sincerely,

Robert H. Gifford
Executive Director

RHG:bhe
Enclosures

SERVING THE STATES OF THE SOUTHERN GOVERNORS' CONFERENCE

APPENDIX J

FOLLOW-UP OF GRADUATES QUESTIONNAIRE

FORM FOR TELEPHONE INTERVIEW WITH TRAINING INSTITUTION REPRESENTATIVES

Institution ______________________________

Representative ______________________________

1. Thank you for your cooperation in returning the SINB questionnaire.

2. You listed ________ (number) of graduates in Program Code ______________ ______________________________ for 1970.

3. We would like to know what type of positions the graduates took and locations of their jobs.

   a. Nuclear field-how many-what types of jobs.

   ____

   ____

   ____

   ____

   ____

   b. Outside the nuclear field ______________________ (how many)

   c. Continuing their education ______________________

   d. Military Service ______________________

   e. Unemployed ______________________

   f. Unknown ______________________

Thanks for the cooperation.

VITA

Krishan K. Paul

Candidate for the Degree of

Doctor of Education

Thesis: ANALYSIS OF SUB-PROFESSIONAL MANPOWER SUPPLY AND DEMAND IN NUCLEAR RELATED INDUSTRIES

Major Field: Vocational-Technical and Career Education

Biographical:

Personal Data: Born in Ferozepur, Punjab, India, April 5, 1929, the son of Girdhari L. and Maya Paul.

Education: Attended grade school, high school and college in Ferozepur, India; graduated from Punjab University, Chandigarh, Punjab, India, in 1949; received Bachelor of Arts degree with a major in Mathematics; attended Delhi Polytechnic, Delhi evening classes in Automotive Technology, 1951-52; Master of Science degree from Oklahoma State University, Stillwater, Oklahoma, May, 1970, with a major in Technical Education; completed requirements for Doctor of Education degree with a major in Vocational-Technical and Career Education, in May, 1972.

Professional Experience: Taught Arya High School, Dinanagar, Punjab, India, 1950; apprenticeship, 1951-52; Foreman, Repair Division, Dass Workshop Ltd., Delhi, 1953; Associated Traders and Engineers as Manager of Service Garage, 1954-58; Inspector, Motor Vehicles and Licensing Authority; Government of Nogaland, India, 1959-66; Programmer Analyst, OTIS, School of Occupational and Adult Education, Oklahoma State University, 1968-70; Oklahoma State Department of Vocational and Technical Education, 1970-71.

Professional Organizations: Phi Delta Kappa, American Technical Education Association, Oklahoma Technical Society, and American Vocational Association.