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# A Report on the 1972–1973 Term of the Oak Ridge National Laboratory Environmental School

E. Eichler

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Program Planning and Analysis

# A REPORT ON THE 1972-1973 TERM OF THE OAK RIDGE NATIONAL LABORATORY ENVIRONMENTAL SCHOOL

E. Eichler

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# I. INTRODUCTION

The Laboratory has carried out a variety of staff educational functions over the years, ranging from the small scale -- reimbursement of fees for university study -- to the elaborate -- the Oak Ridge School of Reactor Technology. The outstanding success of ORSORT in converting chemists, physicists, and engineers of varied stripe to reactor technologists led ORNL management to consider another such program, and the then rosy prospects for funding growth in environment-related programs suggested the subject area.

This report will describe the enterprise as it emerged from planning into reality. After a summary of the pre-history of the School, the events of its first and only year will be detailed. Implications of this experience for future educational programs will be discussed. The reactions of staff and student body will then be presented. Appendices will include important documents relating to the School's formation, as well as the "vital statistics" of the School, including the student and staff listings as well as funding details.

Even though a number of other official and unofficial titles appeared in memos and formal documents, we shall refer to the enterprise in this report as the ORNL Environmental School. This was the operational name used by the participants and concerned observers.

## II. CHRONOLOGY OF THE 1972-73 TERM OF THE ORNL ENVIRONMENTAL SCHOOL

### A. The Formative Period

Beginning in the fall of 1971, the possibility of mounting an "environmental ORSORT" was the subject of informal discussions involving members of management, key people in the environmental area, and the Planning Group. These ruminations culminated in the assembling of a Panel for In-House Education in Environmental Sciences and Ecology. The report of this group's meeting on December 13, 1971 became the basis for the writing of a formal proposal; this report is reproduced as Appendix 1 to this report. At this stage, two schools were envisioned: one in ecology and the other in environmental effects. During February and March, the evolution of the draft proposal reflected the Planning Group's attempts to incorporate into the plan the suggestions of the ecologists (Auerbach, et al.) and the impact statement group (Struxness). Even at this stage, the ecologists expressed great doubt that a physical scientist could be retrained as a full-fledged ecologist in one year and thus would continue to fill their needs in that area from new hires. However, "ecologically indoctrinated" physicists or chemists would be very valuable as adjuncts to a variety of their programs. By contrast, Struxness was confident that a properly organized environmental effects school would produce a better crop of impact writers.

Structurally, both of the branches of the School were conceived with a half-time lecture, half-time on the job training format. The planners envisioned accepting voluntary enrollments as well as nominees from division directors and the Laboratory "mobility coordinator." The program would be advertised in the <u>ORNL Staff Newsletter</u> and through direct memo to the monthly rolls -- a high degree of visibility. Finally, a screening process would guarantee selection of an outstanding student body.

Since such a school concept implied an autonomous operation independent of pre-existing educational entities, the School would have its own director. The Planning Group spent considerable time on both the general qualifications and the specifics of a director. The final draft of the proposal is included as Appendix 3. H. W. Schmitt was the major contributor to this document with the assistance of C. C. Burwell and F. Plasil.

In late May, the Planning Group surveyed the Biology Division, Reactor Division, the ORNL-NSF Environmental Program, and the Environmental Impact Group to determine future employability (at ORNL) of graduates of the Environmental School (cf. memo from C. C. Burwell to R. S. Livingston, Appendix 3). Only the Impact Group made a firm commitment to make use of the School's output. In fact, Struxness predicted that he could use all the graduates of the first projected class of 20 people. The tentative responses of the other divisions to the Planning Group's "market survey" softened even more in the face of growing budgetary problems at the Laboratory.

It became apparent during the summer of 1972 that many divisions would be required to reduce their staffs. It did appear, however, that funding for the writing of Environmental Impact Statements would at least remain constant. These conditions led to three decisions on the part of management:

1) A school would be established.
2) It would include only the environmental effects portion providing training in impact statement writing.
3) It would be a low-profile operation with no open recruiting of students. Nominees would be requested from the divisions, especially those with severe budgetary difficulties. Consistent with its low profile nature, the Environmental School would not be an independent entity but would be under the aegis of the Office of University Relations, whose head, Lewis Nelson, would be the director.

D. S. Billington, Mobility Coordinator, handled student selection. He screened the nominees' dossiers, rejecting those whose background and records suggested they would not profit from the School. The original goal of 12 students was pushed to 20 (including auditors) when funding problems became even more severe. There were a few unsolicited volunteers for the school; they were rejected with regret since they came from divisions which had no budget difficulty. ORAU contributed one student to the program. In no case was student selection based on imminence of termination. Within the constraints cited above, the best qualified students were selected. This report will not present details of the means by which students were assigned by their parent divisions to the school. However, some impression can be gleaned from the students' views of the School in Section IV. C.

The list of courses to be presented to the School's first class drew heavily on the Planning Group's proposal. Of the five suggested courses, four were actually given. Only "Environmental Chemistry, Effluents, and Their Impacts" was not included. "Movement of Air and Water" was actualized as two courses: "Meteorology" and "Hydrology and Thermal Hydraulics."

Director Nelson recruited his instructors from the ORNL staff and its consultant ranks. Arrangements were made with the Environmental Impact Report Project (EIRP) to assign each of the students half-time to a team for on-the-job training.

During the spring of 1972, the Planning Group has provisionally reserved the MSRE office building (Bldg. 7509) as the site for the School. This structure is ideally suited as a school building since it has numerous offices for the director, faculty, and students, as well as a large conference/class room. The only serious drawback is its remoteness from the population center of the Laboratory, implying awkward transportation problems. The decision was made to live with the geographical separation and use Building 7509. A shuttle was operated each morning from 4500 to the School, and a single vehicle was permanently assigned to the director.

## B. Review of the Events of the 1972-73 Term of the Environmental School

The first class of the ORNL Environmental School convened in Building 7509 at 9:00 a.m., October 3, 1972. The final class was held on June 28, 1972. From a pedagogical standpoint, the academic year was divided into two semesters with four courses taught in the first semester and three in the second. From a psychological viewpoint, the nine months can be divided into three parts: the period of adjustment, the period of hard work, and the period of termination notices.

Even if the students had volunteered for the School, they would have experienced some difficulty in changing gears from long careers as researchers or designers. In fact, the recruitment methods seemed to have tended toward the Draconian. The sudden load of half-time course work, half-time impact statement writing, along with many hours of nightly homework, left at least some of the students gasping for breath.

After a few weeks, the students adjusted to the new life. The following four months were characterized simply by hard work, a sharpening of the focus of course material by the instructors, and a growing sense of comaraderie on the part of the student body.

In February, severe programmatic cutbacks at ORNL led to a need for a large staff reduction. Twelve of the students in the Environmental School received reduction-in-force notices. The effect on the students and, in turn, on the school was profound. Terminated personnel began to devote much time to job hunting: resumé writing and interview trips. One or two who received offers left well before their termination date. For terminated students, the termination date was delayed until June 30, after the end of the school term. In spite of the generally hectic and demoralized atmosphere which characterized this period, classes continued and the students did their work "to the bitter end" (cf. Director Nelson's comments, p. 12).

The employment history of the 20-person student body can be summarized as of the date of this report as follows:

| | | |
|---|---|---|
| 1) | Returned to division of origin | 6 |
| 2) | Employed by ORNL Impact Statement Program | 2 |
| 3) | Transferred to K-25 | 2 |
| 4) | Loaned to AEC Washington (one assigned to impact statement work) | 2 |
| 5) | Hired by outside industrial firm (Environmental School experience of some help for 3). | 4 |
| 6) | Unemployed | 4 |
| | | 20 |

Thus, of the 14 persons trained in environmental impact statement writing and available for new assignments, only three -- two at ORNL and one at Washington AEC -- were utilized for the AEC project. Three of the remaining persons obtained jobs in private industry, more or less related to impact statement work.

A factual "Profile of the ORNL Environmental School" is given in Appendix 4, page 55. This includes lists of students and staff, details of the curriculum, an enumeration of half-time working assignments, and a summary of the cost of operation of the School.

## III. THE ENVIRONMENTAL SCHOOL AND FUTURE EDUCATIONAL ACTIVITIES AT ORNL

Judging from the comments of the Staff and the EIRP group leaders (cf. Section IV), the ORNL Environmental School succeeded in preparing a group of technologists to do effective work in the area of environmental impact statements. During the term the students assisted the EIRP in their half-time work assignments with at least a moderate degree of effectiveness (cf. below). Most importantly, it was demonstrated that scientists and engineers can return to the classroom after a 20-year hiatus and become good students again.

At its inception, the School suffered from low student morale, resulting from the less than voluntary selection method. There was a definite impression that enrollment was equivalent to eventual termination. Coupled to this was the absence of a clearly stated purpose for the School -- no representative of ORNL management ever interacted with the students to enunciate the explicit goal of their enterprise. It is all the more impressive that real learning took place. The student body surprised the faculty with their resilience and high degree of intelligence. Conversely, the students' comments reiterate praise for the faculty.

Thus, the general principle of retraining through an in-house educational scheme was amply vindicated. In spite of the general success of the School, there were many criticisms of various aspects of the operation as enunciated by the staff and the student body in their comments. We will now attempt to summarize the most frequent and significant of these remarks.

Although there was wide agreement that the overall curriculum was well chosen and appropriate to the environmental impact effort, the content of some of the courses seemed to be either too theoretical or too superficial. Much of this could have been remedied by regular faculty meetings and by coordination with EIRP task group leaders, the intended users of the newly-trained talent.

Although the students adapted successfully to the heavy work load, the comments suggest that this remained a live issue throughout the year. As Instructor Burgess succinctly stated (p. 19), the students had a full-time load but only half-time to do it. The School's educational philosophy seems to have been sternly tradionalistic; as evidenced by the grim insistence on letter grades and daily roll calls (cf. comment of student 10, PP. 33-35).

The reversal of several of these policies would have lifted morale as would have the avoidance of the "contract" fiasco. This issue was not dealt with in the textual portion of this report but is described by student 8 (p. 29) and student 10 (p. 35).

The program of half-time work in EIRP task group seems to have been only partially successful. In the first place, assignments were involuntary in that there was no prior consultation with the students. Further, it appears that those assignments with a strong ecological component were not well suited to the students with physical science or engineering backgrounds. On the other hand, those students who were assigned tasks that were an extension of their previous careers did competent, even creative, work (cf. Wichner's comments, p. 37). In retrospect, it may have been better to have placed the greater emphasis on the on-the-job training aspect with the courses linked more closely to the need of EIRP. This would have involved placing students in definite slots in task groups, which would have removed them from the status of "men without a country."

This statement leads to the most unfortunate event of the School term, namely the termination of the majority of the students. That this action was an unavoidable consequence of the reduction of the EIRP budget as well as the severe Laboratory financial crisis cannot minimize the personal tragedies involved as well as the consequences for future educational functions. It will be difficult for quite a number of years to persuade Laboratory staff members to cut their ties with home divisions and attend this kind of a long-term school with no definite assurance of future employment. Admittedly, the school experience should broaden the students' backgrounds and thus might enhance their employability outside the Laboratory, but this should not be used as the main argument for such a school.

In-house education at ORNL is essential to the Laboratory's continued vitality. The evidence seems to call for a two-fold program. One part, would be short-term in nature to answer urgent needs of the funding agencies and quickly respond to the sudden arrival of funds in a new area. The second aspect would be a long-term continuing education program patterned after the Bell Laboratories INCEP effort (cf. Appendix 5, as well as the comments of Instructors Gill, p. 16, and Burgess, p. 18, and Student 7, p. 26). This would be a collection of courses in varied fields presented during working hours. Some courses would be in the traditional fields, occasionally at the elementary level, some at the frontiers, and others inter-disciplinary. The staff would be surveyed in developing the course list, and enrollment would be completely voluntary. The early institution of such a program would give strong evidence of management's deep commitment to long-term staff career development.

## IV. EVALUATION AND COMMENTS

Comments were solicited from all of the participants in the School.

A. Lewis Nelson, Director

A school can only be as good as its students, its faculty, and its administration. As a guess, because such a thing can't be measured, I would place the quality of the students at about 80%, that of the faculty at 15%, the administration's at 4%, and all else at 1% or less in their relative importance in determining the worth of a school. The context in which the enterprise is set is hugely important, of course, but however unscientific it may be to do so, I let its influence implicitly appear in the quality of the school's components.

When we began to organize the Laboratory's School for Environmental Impact Statements in mid-summer 1972, I had grave misgivings of its likelihood of success. My apprehension increased with time, prior to the School's beginning in early October. A curriculum had been set down by Hal (H. W.) Schmitt who had done a competent job -- who knows what the curriculum of such a school should be? Moreover, even if one believes that he knows what should be taught, agreement among the faculty is crucial and there was no faculty. I will say more of this below.

The gravest question was who the students would be. It was known that they would not be young, indeed that, for this purpose if not absolutely, they would be old. In addition to their age, they would be losing jobs held for times as long as twenty five years, and they would be confronted with the prospect of a major change in career. It wasn't possible, I believed, for a school of such students to amount to much. Their physical inability, to say nothing of their emotional inability, to work as hard as graduate students must willingly work was in itself enough to guarantee a poor result. Heaped on that was the selection of the students and their consequent confusion.

I have no criticism to make of the manner in which the students were selected and the time it took to do it. Given the circumstances under which it had to be done, there simply was no way that was either good or short. Time was required and the agony of extremely difficult decisions had to be endured, not by any one person, but by many. While it could not have been otherwise, a few days before the School was to begin, it was presented with a body of students whom I will describe as bewildered, although that is a woefully inadequate description of their actual state. The School, it seemed, began with a handicap.

Let me return to the faculty. In this quarter one might say that the Laboratory was lucky or rich. Within its easy reach was Frank Gifford, meteorologist; and within it was Sam Beall, expert in central power stations; Gurmukh Gill, economist; and Bob Burgess, ecologist. Soon to come to ORNL were Jim Duguid and Pat Ryan, hydrologists. Each of them not only had expertise and a willingness to teach, but a good measure of common sense, the uncommon kind. Moreover, each of them is good natured and understands the value of humor -- it has been my observation that the teacher who takes himself too seriously invariably fails. Without exception, the faculty intended to teach only what was believed would be of use to anyone, whatever his specialty might be or come to be, who would participate in an assessment of the impact on the environment of a nuclear power station. While there may be some disagreement as to how well the intention was fulfilled, there is no doubt as to the intention itself. On this point there was some, but less complaint than one could reasonably expect from the students. Here I permit myself to say what every teacher knows: namely, students are universally poor judges of what they should learn. Otherwise they aren't anybody's students; they go to the sources and learn without guidance as some have done -- Newton, for example.

The members of the faculty were listed above, with one important exception, Bonnie Straine, the School's secretary. Properly, Bonnie should be named as part of the administration, as <u>the</u> administration, if the truth must be told. But that would require a revision of the relative values I have ascribed to the various segments of the School, which is unthinkable. Both luck and wealth gave us Bonnie; the Laboratory was rich enough to possess her, the School was lucky enough to find her. She did a monumental quantity of high quality work. Without fail she saw what needed to be done, did it at once and did it well, everything from the dirtiest chore to those things to which the elite tend to confine their attention. All of that would have been more than one ordinarily expects, yet it was the lesser of her major contributions.

It was an ugly transformation that hasn't a fixed point; Bonnie was our fixed point. For those who may not understand that analogy, let me say that she gave everyone comfort, mostly by the simple, but difficult, device of listening to anyone who wanted to say anything. I should add that there were many on many occasions who wanted to talk. She listened.

As matters now stand in this narrative, the School had all but about eighty percent of what it needed for success. Flatly stated, I judged the students wrongly. They could and did work hard, very hard. Since all of them are able people, some of them unusually able, there isn't much more to be said. They learned a great deal. Judged by that criterion, the School was a success.

I wish to say a little bit about the students as they turned out actually to be. It is easily done: they were first rate. They attended the classes regularly right down to what, if the School were a piece of line, a sailor would call the bitter end. Problems were done and handed in, reading assignments were read, "term papers" were written, examinations were taken; in short, the tyranny of the instructors was endured calmly, steadily and with good humor. I praise the students, for they did meet the chief requirement of a good school.

Each student was supposed to work half-time, on assignment, in the Laboratory's preparation of environmental impact statements. I did not, perhaps irresponsibly, make it my business to know what each of them was doing and how well he was doing it. Others must report the degree to which this aspect of the educational enterprise succeeded.

Should the Laboratory undertake another school, my advice would be that it be very careful. Although I claim that the School for Environmental Impact Statements was a good one, I doubt that we know or will easily discover why it did well. There is no assurance that in another case the essential ingredient, whatever it was, would be present. My list and their relative importance, given in the first paragraph above, ought not be taken too seriously. Education has been the subject of endless discussion, debate and controversy in Western civilization since the days of the Greeks. In China and elsewhere, its history is long and no doubt equally uninformative.

The Laboratory surely can deliberately educate its employees either for a specific purpose or for a general purpose. The circumstances under which it is done and the purpose for doing it largely determine how it might be undertaken -- there is no uniquely best way. To be sure, the Laboratory ought to keep its past experience in mind. Yet I advise that in its next attempt to educate its people, it rely on only those elements of its past which are genuinely understood. With that restriction, which is small, let any other beginning be a brand new beginning.

## B. The Faculty

### 1. S. E. Beall, Energy in Society

Although dimmed by memory, a few impressions still remain of the Environmental Impact School as follows:

1. The School curriculum was only approximately matched to the needs of those preparing to write environmental impact statements. More thought should have been given to the content of the course work prior to the start of the School. Some of the course work, according to student comment, was much too theoretical.

2. Although there was some attempt to have faculty meetings to assess progress and make changes in administrative and curriculum matters, I think more attention should have been given to improving and revising the curriculum and administration throughout the school year.

3. There was quite a difference in the understanding among the students as to why they were in school. Many knew from the beginning that they were on the termination list, whereas others fully expected to return to their divisions after having been equipped to work in a new area. Whether true or not, there was considerable feeling that they had not been told the truth by management.

4. When it was realized that students would be terminated at the end of the School session, a stronger effort could have been made to place them as what they were: environmental school graduates. Whereas few of these students obtained jobs elsewhere in industry as fired ORNL employees, I believe that their prospects would have been much, much better

if they had been advertised from the beginning as graduates of a new school in environmental statement preparation.

2. F. A. Gifford - Meteorology

This course consisted of a series of 27 lectures during which I covered basic principles of atmospheric physics, atmospheric diffusion theory, planetary boundary layer theory including wind profiles and spirals, and calculating dispersion from various kind of sources, including points, areas, and so on. The emphasis was on practical methodology, particularly during the latter half of the course. Cooling tower plumes and terrain, stacks and building aerodynamics were covered in some detail.

I considered the level of ability of the student group high, and their responsiveness and general willingness to work was impressive. They had problems initially with trying to see the relevance of quite unfamiliar material, but this more or less disappeared when we got deeper into the applications. If this course is ever given again, the instructor should work hard on relating the initial, general background material to the ultimate practical applications. I'm not exactly sure how this is to be done, but I am sure I'd work harder on it than I did.

There were, of course, some problems stemming from the heterogeneous backgrounds of the people in the group. These are the usual ones, I suppose, of the engineers being accustomed to a different set of units than what the physicists or biologists use. On the whole, I think this is an unavoidable problem with a group like this. It can't really be helped. The other side of this coin is that there was usually someone in the group who could help me over a rough spot in, say, chemistry, biology, or engineering by virtue of more detailed knowledge.

A few homework problems were given out during the course and then reviewed in class, and there was a fairly large final, "take-home" problem set. A few people commented that they found the problem set quite useful and instructive, which of course was the intention. In any future version of this course, I believe I'd try to do more of the practical problem-solving, though of course it takes a lot of time all around (including writing and checking the problems).

I suppose that all the instructors would have wished for some kind of a preliminary math and statistics refresher to be given (as used to be done at ORSORT) to the students, or at least to those who were rusty.

3. P. J. Ryan - Thermal Hydraulics

A series of ten lectures on various aspects of waste heat dissipation from electric power generation was given in the Environmental School from May 29 to June 28. The course content was based on a one week short course on this subject, given at MIT by Marleman et al. in 1971 and 1972. The content was as follows:

Lecture 1: Origin of waste heat, efficiency of power generation, typical condenser flows and temperature rises.

Lectures 2 and 3: Environmental heat transfer, stressing the differences in heat transfer between a natural and artificially heated water surface.

Lecture 4: Thermal behavior of natural water bodies including rivers, estuaries, fully mixed and vertically stratified lakes and reservoirs.

Lecture 5: Cooling pond behavior, prediction of thermal performance of off-stream ponds, and lakes and reservoirs used for cooling purposes.

Lecture 6: Surface discharges; this lecture was given by Dr. K. D. Stolzenbach from TVA. Dr. Stolzenbach developed one of the best of the known surface jet models.

Lecture 7: Submerged jets and multiport diffusers, concentrating on recent work in this area which stresses the behavior of submerged discharges in shallow water.

Lecture 8: Far field behavior, with emphasis on the role of diffusion and dispersion.

Lecture 9: Cooling towers; this lecture was given by Dr. S. Hanna from ATDL. Dr. Hanna has done considerable work on cooling tower plumes, and discussed the recent experiments on the K-25 towers.

Lecture 10: Physical models; the role of physical models in predicting the behavior of thermal plumes, cooling ponds, and stratified withdrawal was discussed.

The time restraint of ten 45-minute lectures meant that the coverage of the above topics was somewhat superficial. The intention throughout was to stress the physical behavior of the various systems and mathematical models were neglected to a great extent. This imbalance was partly dictated by time restraints but, to some extent, was a deliberate policy on my part, as there is a tendency in this field to rely too heavily on computer models without fully understanding their ramifications.

4. J. O. Duguid - Hydrology

In my opinion, the Environmental School served the important function of retraining personnel for new job opportunities both outside and within the Laboratory. Many of the job offers made by companies were made on the basis of knowledge the students had gained from courses taught in the School. I was pleasantly surprised at the high morale and academic attitude that existed within the School at a time when employment prospects for the students seemed very grim.

5. G. S. Gill - Economics

I am setting down some thoughts emerging from my association with the Environmental Effects Training School:

1. <u>Administrative and Organizational Aspects</u>

The organization and administration of the School was quite satisfactory. The work of the School went on effectively and efficiently without any let-ups or hindrances. The location of the School could have been more central, thereby economizing the time spent by all the participants in travelling back and forth.

I am not fully aware of the criteria which governed the selection of the trainees. In general, the trainees showed a high degree of interest and enthusiasm and that may have been attributable in part to a considerable degree of voluntary participation in this program. Despite layoffs and the associated morale problems toward the latter part of the school year, attendance rates remained high, and the interest in class work remained reasonably satisfactory even though it did register a notable dip in some cases. The difference this training program made will largely remain a matter for speculation. If all or most of the trainees could have been deputed to work on environmental impact statements as initially envisaged, the impact of this training would perhaps have become clearly discernible.

2. Comprehensiveness and Relevance of this Training

Keeping the specific purpose of the School in view, the training provided was quite broadly based. Even though a few months of training in economics, ecology, hydrology, etc., could not be expected to make the trainees experts in those areas, their perception of the environmental impact work could nevertheless be expected to be clearer and more comprehensive with this type of training than it would have been without it. Such training would certainly have lent them the much needed confidence and ease in taking up their new duties.

3. Merits of Similar In-house Training Programs

With rapidly changing technology and with the consequent inapplicability of past training, in many cases, a continuing need for retraining, either on the job or through special refresher courses, is already manifest and may become more so in the future. We may soon find such a need becoming obvious as the role of the Laboratory and its staff changes from nuclear research to research pertaining to all forms of energy. In this context, learning on the job may be slower and also more difficult. Some help in the form of in-house formal instruction could facilitate adaptation by employees to their changing functions. Although the participants in the Environmental Effects School were relatively older, their ability to learn and zeal for learning were high enough to warrant optimism about the results of retraining efforts. However, to the extent feasible, such facilities for instruction should be organized on a continuing basis instead of launching a crash effort after an actual need has already materialized. Advance planning of such instruction and training could facilitate redeployment of staff consistent with changing needs for newer skills and expertise.

Carefully selected courses should be offered on a continuing basis and the staff encouraged to take advantage of such facilities. The degree of voluntary participation can be a good index of how well matched the particular plan of instruction is with the changing needs.

4. Selection of Teachers

The teachers should be selected carefully. Their willingness to offer courses should be borne in mind. However, to create such a willingness among competent personnel, their participation in teaching effort should be given high recognition and rewarded in the same way as their research output. Their contribution to enhancing staff skills may lead to enhanced overall output at the Laboratory and increased happiness of the trainees through their improved ability to stay abreast of their changing roles.

It can be argued that the interested persons can go to the University of Tennessee, Knoxville, and take the needed courses. It may indeed be a desirable course of action in some cases. However, in many cases, attendance of courses at U.T. involves substantial loss of time in commuting back and forth. Also suitable types of courses may not be available at U.T., either at all or at least at the right time; even when available, their focus may be entirely academic. What is needed, on the other hand, is pragmatic, to the point, and practically oriented instruction. This is, by no means, an exhaustive list of reasons, but some or all of them may often be applicable pointing out (1) the need for suitably devised in-house training courses or (2) a suitable combination of in-house training with participation in relevant and available courses at U.T.

5. Planning for Such Courses on a Continuing Basis

The courses once initiated should be subject to a continuing scrutiny with a view to eliminating those which may become redundant over time and introducing those the need for which may be perceived later. Such a continuing review will keep the in-house training program well attuned to the current and prospective needs of the Laboratory and its staff.

6. Robert L. Burgess, Ecology

In an attempt to evaluate the in-house School for Environmental Impacts organized at ORNL, I believe it is pertinent to look at several topics, all of which play a contributing role. These include the CONCEPT, the SUBJECT MATTER, the ORGANIZATION, the STUDENTS, and the RESULTS.

The concept of the School, in which competent scientists were to be "retrained" for another role in society, is basically sound. As presented, however, the element of choice was eliminated; the School was therefore instituted as a company contribution to potential terminees. Such a school would be better conceived if people were being trained for existing slots, or if a series of courses were opened to the general staff for their edification. Education comes best by desire, not by force-feeding in a situation *a fait accompli*.

I think the subject matter was well chosen in the five courses offered, providing maximum breadth in the time allotted. The only obvious omission was exposure (even a minimum) to demography and the social impacts of technology. This could have been programmed, perhaps, as a series of five or six "special lectures" scattered throughout the year.

Class times were minimal, and while the circumstances were extenuating, more time could have been effectively used. The students were essentially in a full-time college curriculum, yet were expected to devote only half-time to the School. It is not surprising that there was a collective request for a reduction in classroom time. Compounding this problem, of course, was the fact that the instructors were also busy people, and the amount of non-classroom contact with the students was less than desirable. The instructors were provided with an office in Bldg. 7509, but none of us, all who came some distance to the School, ever even began to move in a set of references or other library materials that would normally be available to both students and instructors in a university environment. Consequently, the individual contact so prevalent in a university was absent at ORNL. Only two students ever found their way to my office to discuss materials presented in the course.

In spite of these problems, I sincerely believe that ALL of the students finished the school with an ability to constructively function as <u>part of a team</u> involved in the assessment of the environmental impacts of technology. No one would be qualified to start his own consulting firm, but all would be an asset to a group effort. In this sense, the School was successful.

In the long run, I believe that ORNL would be well advised to establish a continuing program of in-house higher education offered on a completely optional basis. I know nothing of thermonuclear physics, for example, and a basic course would be of interest to me. Similarly, I can envision some math, statistics, or computer courses being popular, as well as something like Sam Beall's survey of energy technology taught during the Impact School. A broadening of individuals, through competent instruction, should yield high dividends in an institution such as Oak Ridge National Laboratory, and I would urge that something of the nature outlined above be given serious consideration.

## C. The Students

Comments were solicited from all of the students except one who had left the country. Ten responses were received and are reproduced below. Most of the respondees did not avail themselves of the offer of anonymity. However, to preserve the privacy of the minority who did, no names are appended to the following. Minor changes were made to a few of the notes to preserve anonymity.

### 1. First Student

The School has gone through evolution, both in purpose and scope. When my section chief first invited me to allow my name to be submitted late in July 1972, the purpose he emphasized was not just to learn environmental impact statement writing but to prepare one for the broader environmental role the Laboratory intended to serve. By the time classes started in October, the School had clearly become oriented to educate one to prepare and manage impact statements. Even with the purpose decided, some individual instructors initially were not sure what to teach. Two of them asked the class for guidance on occasion. Environmental chemistry, although included in the initial outline, was omitted. A large portion of the class (at least 16 out of 23), being chemists or chemical engineers, already had adequate knowledge in the field. The classes tended to become better taught and the material better selected as time went on, so that we ended up with a very interesting, enjoyable course pertinent to the writing and management of impact statements.

Unfortunately, very few people in the course, it seems, will have formal use for the training. Of the 17 people who started the course on a full regular basis and 6 others who "audited" the course, only 2 or 3 have positions on environmental statements at ORNL; one has found a job on environmental impact reports outside ORNL, and one has found less directly related outside employment. Of the approximately 11 people given job termination notices on February 16, six have not yet found any employment.

One problem in the use of this training to find a job is that ORNL, which offers the course, is not a university and does not give formal academic credit for the course of study. Accordingly, most prospective employers do not know what to make of it. Most personnel departments put definite labels on people and jobs based on the formal degree held or required. This school just doesn't fit their system. I have tried to get across the value of the School by distributing a course outline to prospective employers.

In addition to technical education received in the School, a certain rapport or spirit of brotherhood has developed among the students. Even though in competition for jobs, the students are often helpful to each other in the job search.

2. Second Student

The Environmental School conducted at ORNL during the 1972-73 academic year was a very worthwhile and interesting educational experience. A brief discussion of the strong and weak points of the program follows.

STRONG POINTS

1. Selection of Courses. The topics covered were critical to environmental study and research. Although one might criticize some aspects of the manner in which the program was presented, no one can find fault with the selection of courses (energy, ecology, economics, meteorology, hydrology). The only changes I could suggest would be the addition of topics on environmental pollutants, politics and environmental regulation, and legal aspects of environmental control.

2. Instructors. The instructors were excellent. They were conscientious, highly qualified, good teachers, friendly and cooperative in every way.

3. Schedule. Classes in the mornings with environmental impact statement work in the afternoons was an appropriate schedule for this activity. Beginning at 8:30 a.m. instead of 8:00 a.m. was a definite advantage to students and instructors since most had offices to visit before class each morning (9:00 a.m. might have been even better).

4. Environmental Impact Statements. Working with ORNL task groups on environmental impact statements provided practical experience to reinforce the academic work in the classroom. If properly supervised, the novice in this area can be of considerable use to these task groups while learning the fundamentals of impact statement preparation.

## WEAK POINTS

1. Coordination of the Program. There were numerous situations where closer coordination between instructors would have enhanced the program. Economics could have been related to certain topics in the energy course, and hydrology topics related meteorology, but they were not. I realize that the instructors are busy people, but some effort of coordination among them should be made if this program is pursued in the future.

2. Classroom Problem Sets. The best educational experience of the meteorology course was the take-home problem set at the end of the course. Problem sets that could be worked under the supervision of the instructor would have been a great help in economics, hydrology, meteorology, and energy. I do not refer to homework but to problem sets that would be worked in the classroom.

3. Environmental Impact Statements. The work on environmental impact statements was helpful from the point of view that a little experience is better than none. This part of the program could be improved immensely. At times, I made a real contribution to the impact writing, but more often I was involved in "busy work" or no work at all. (I am aware of the difficulties in trying to write impact statements and having students hanging around; but again, a little coordination could have improved the situation greatly.)

## CONCLUSION

Course critiques tend to be somewhat negative in tone because the critic feels mainly called upon to point out weaknesses in a program.

I would like to state emphatically that the ORNL Environmental School was a good program with many excellent features. Improvements could be made in the areas of course coordination, classroom problem solving, and impact statement work.

3. Third Student

Although I did not volunteer to attend the School, it turned out to be very interesting. I spent about twelve hours per week in class and about the same amount of time doing homework in the evenings and on weekends I received my termination notice after about six months of the nine-month School were finished. Interviews were arranged for me with AEC Regulatory, General Motors, TVA, and NUS. AEC said that at my age I could not compete with younger kids just out of college with more formal training in environmental sciences than I had (I'm over 40 with a B.S.).
TVA sounded favorable and put on my application available July 1. This was for a laboratory analyst job. They weren't too interested in me as an environmental impact statement writer. General Motors wasn't interested in me. I think I could have gotten a job with NUS at the same salary I'm making, but the cost of living in the Washington area is much higher and I didn't want to live there. I finally arranged an interview with the K-25 plant and accepted a job as a Senior Laboratory Technician. I dropped out of the School and began to work at K-25 on April 2.

The Meteorology was interesting, but I had a hard time following Dr. Gifford's lectures. We were given many reports with lots of equations. Finding the proper equations for definite weather conditions etc. is the secret to this course -- I think. I dropped out of school before the important part of economics was covered (cost-benefit analysis). The Ecology was interesting but required much memorizing. The need for protecting the environment was brought out more and was more clearly seen in this course than the others. Dr. Burgess was probably the best teacher in the School. Energy Systems was also very interesting, and Sam Beall was the second best of the instructors -- in my opinion. The energy crises were clearly demonstrated and alternative energy sources were discussed. Much memory work was required, but this was the easiest course for me.

The on-the-job training writing environmental statements was not very helpful in my case. Since the reactor project I was assigned to was just getting started, we spent most of our time waiting on a revised statement from them. I did library research, made species list, etc., while waiting, as well as studied completed environmental statements to learn how they are written and compiled.

Although I am more aware of our environmental problems, the School didn't save my job at X-10, and it didn't help me get the job at K-25.

4. Fourth Student

To evaluate the school as a unit, I must first give some consideration of the individual courses offered. My opinions and impressions follow.

1. Meteorology. For the first two months, we were deeply emeshed in mathematical derivations of fundamental equations related to the subject. Eventually, Frank Gifford came to realize that we were not scheduled to pursue this approach as part of environmental impact analysis and revised the classroom work along the lines of practical problem solving. Meteorology is far too complex for any of us to have become qualified meteorologists in a few months, but we gained considerable insight into it and learned the terminology, at least.

2. Energy Systems. For me, this was a very practical, well-organized series of classes. Sam Beall presented a wealth of background information and up-to-date data related to U.S. energy problems. Numerous visiting lecturers, experts in their fields, kept interest high. For anyone going into environmental impact analysis, no matter what phase of it, this course gave necessary information that allows understanding basic problems of the need for energy sources.

3. Economics - The instructor, G. S. Gill, has made a sincere effort to give a series of lectures that presented a rather complete background in economics. It is likely that we have been given more background material than was really necessary. For our purposes, more time could have been devoted to benefit-cost analysis applied problems, perhaps by ORNL personnel working in benefit-cost analysis for environmental impact statements.

4. Hydrology. The two instructors, Jim Duguid and Pat Ryan, may have come the closest to ideal in developing lectures that gave an overview of their subject. They recognized the shortness of time available and rapidly covered material that let us have a look at the potential problems and gave us a degree of familiarity with terminology. Despite the short time available -- less than any other course -- it is likely that we can do useful calculations of the more straightforward problems involved in hydrology.

5. Ecology. Perhaps due to a personal interest in plant and animal life and perhaps also due to the captivating personality of the instructor, this was the most interesting course offered. Bob Burgess is not a lecturer -- he is an orator. His lectures, coupled with the opportunity I had to work in the aquatic biology group on impact, allowed me to learn a great deal that undoubtedly will be of benefit in assessing various power plant impacts on ecosystems.

Summary and Conclusions. Despite assurances otherwise, I felt and recognized that I was in the School most likely as a reject from my former division -- borne out by my termination. Management's goals in establishing the School and choosing the participants were never known. The instructors associated with the School all made genuine efforts to give us valuable and useful information and were very successful at it. I have a warm outlook toward the School because it netted for me an interesting job offer from a reputable employer.

5. Fifth Student

1. Students were arbitrarily selected by management. It would have been better if students were selected on a voluntary basis.

2. About half the class was given notice of termination in February. This was bad for morale and interfered with effectiveness of the School.

3. Energy in Society Class. Considerable material was covered; some of it was covered rather superficially because of time requirements. For instance, only one lecture was devoted to pressurized water reactors.

4. Economics Class. Most emphasis placed on microeconomic theory. Although an effort was made to bring material related to benefit/cost

analysis early in the course, I did not consider it to be too successful. We were asked to turn in a benefit/cost term paper when we hadn't completely covered benefit/cost analysis in class. This could have been corrected by scheduling the class so that it would end at an earlier date.

5. Ecology Class. Instructor wisely chose to provide a foundation of biology since many of us were deficient in this regard. Ecology principles seemed to have been covered fairly well.

6. Meteorology Class. Instructor provided set of notes for material given in class, and this was very useful. Material in early part of course seemed to be theoretical and as presented was beyond my ability to understand easily. The course would have been better if more problems had been worked in class.

7. Hydrology Class. The textbook used was not too good, although it may be the best available.

6. Sixth Student

A comparison made between the materials studied in the Environmental School and that for an environmental engineering degree shows that essentially the same materials were covered in both -- the main difference being that more time was required to complete the environmental engineering studies in college. Since the instructors for the School were each leaders in their respective fields, it must be assumed that the instruction given was equal to or superior to that at most colleges. I think it is fair to say that the students of the Environmental School are well equipped to do environmental work and should be given the opportunity to do so.

7. Seventh Student

Without a clear understanding of the aims of the subject School -- a rumored spectrum ranging from a retreading of old scientists to the enlightenment necessary for writing relevant EIS -- an objective evaluation is very difficult. However, I shall try to summarize the good (advantages) and bad (disadvantages) things about the School as I saw them.

First, a general statement. Whatever the purpose of the School -- and it may have changed somewhat as circumstances during the year changed -- my opinion is that the School was of considerable value both to the participants and to the Laboratory and AEC. In fact, a continuing in-house education program, in my opinion, could be most rewarding -- in the long run to ORNL, and short-range, to its immediate programs. For this I visualize two more-or-less distinct programs: an in-house education program to provide background information and to update the knowledge of the staff but not as intensified as the subject School, and a seminar-type program providing sufficient background and current information on a particular national problem for the staff to contribute its expertise through discussion and evaluation (a forum). In this regard, the results of a careful investigation into other in-house education programs would be most helpful.

Advantages (good points) of the subject School, in addition to general background information of the subject matter (meteorology, energy, economics, ecology, hydrology), included the experience of field trips (firsthand inspection of nuclear and fossil-fuel energy facilities, efforts at pollution abatement, large-scale ecological studies), the discussion of avant-garde ideas or studies for pollution control ($SO_3$ injection system to improve control of fly-ash emissions at Bull Run, photolysis of hydrocarbons to simulate solar contributions to smog from automobil exhaust emissions, "unconventional" electric power transmission), and the exposure of controversial opinions on currently proposed solutions or interpretations of data (Tyrrell vs. Beall on electricity demand growth, hazards of $SO_2$ stack emissions vs. crop benefits by replenishment of soil sulfur, ineffectiveness of wet cooling towers in the Southwest).

In my opinion, the disadvantages (bad points) about the subject School were minimal, especially for a prototype. Probably each participant had his own gripes, the airing of which is undoubtedly one of the purposes of this evaluation. Areas which in my opinion could be improved or should undergo careful evaluation, are:

1. An imbalance or uncoordination of course assignments or requirements. Bad: reading assignments that were overwhelming when required for several courses simultaneously and without regard to other responsibilities. Good: Beall's summary of important facts from his required reading assignments; Duguid's problem assignments (of considerable value,

incidentally), given when competitive assignments were minimal; Beall's term paper, assigned over 5 months before due.

2. An over emphasis on letter grades for final subject "credit." Granted that an incentive to do well in "school" is required, methods other than letter grades should be explored (pass-fail?). School management (but not the instructors) and the AEC (?) appeared obsessed with this traditional method of student evaluation and motivation.

3. Discontinuity of presentation of subject material. This occurred primarily only in Economics when the instructor (Gill) had a prior commitment to teach at U.T.

Plaudits should be given the instructors of the subject School: Beall and his ORNL guest speakers (Energy); Gifford (and Hanna, Meteorology); Burgess (Ecology); Duguid, Tamura, and Ryan (Hydrology); and Gill (Economics). Only the latter seemed to lack the necessary finesse required of the situation, but his evaluation of most of the students in his course will undoubtedly show an alarming unpreparedness in his subject (which, incidentally, is a reason for an in-house education program).

I cannot miss this opportunity to emphasize my belief that a continuing research-seminar type program should be instituted. Speakers from outside the Laboratory as well as within should be involved to provide background information and current progress in fields of interest, and to act as the catalyst for eliciting ingenious solutions to urgent national problems. The energy seminars last year and the "Interdivisional Energy Seminar" of July 30, which took place while I was drafting these comments, are examples of the type seminars that should be made a continuing, permanent program at ORNL, especially if we are to take on new responsibilities in energy research and development.

8. Eighth Student

"Trail of Tears"

I. General Comments

1. Study time. Classes were conducted for approximately four hours per day, four days per week. The balance of the time available during the work week was to have been spent reviewing and rewriting environmental impact statements. If we use the old college ratio of two hours of study time per hour of class time, we then have an average of 32 hours of study

time per week which was to have been on our own time after working hours or on weekends. This is a rather high price to ask each student and his family to pay, especially since the reward to most has been termination. I do not believe that any other school conducted at the Laboratory has had these requirements and certainly not the rewards---termination.

2. Vacations. Dr. Lewis Nelson, who seemed to function as Dean of Students, told us prior to the beginning of the School that arrangements would be made for those of us who had not taken our vacations to transfer vacation time into the next calendar year. When I tried to transfer one week, I was refused. Dr. Nelson told me to take my vacation while the School was not in session at Christmas time. As a result, it was necessary for me to come to work while on vacation in order for me to complete my assignments. Furthermore, one of the other students was allowed to carry over vacation as provided by the company rules and then was allowed to carry over one additional week.

3. Contract. Several months after the School had been started, Dr. Nelson distributed to us a contract which provided that we would work for the Laboratory at least 13 months following completion of the scheduled classes. If we left the Laboratory prior to the 13 months, we would have to pay 4 1/2 months of our salary to the Union Carbide Corporation for the account of the government. There were, of course, exceptions which would be handled on an individual basis. One of the terms of the contract said that the Laboratory was not obligated to employ us.

4. Termination. A majority of the students in the ORNL Environmental School were terminated in February 1973. Time has proven that the students and their recently acquired skills were not in demand at the Laboratory, in the AEC, in other governmental agencies, nor in private industry. Certainly six unemployed people at the present time can attest to that statement.

5. Financial Losses. The financial losses that my family and I have been forced to sustain are very serious and severe, probably about average of other individuals terminated.

a) Pension. At age 55, I would normally be entitled to receive a monthly pension of $315. By being terminated earlier, I shall now receive $170 per month at age 55. This corresponds to an annual loss of $1740 per year and for a normal life expectancy of 72 years, a loss of $29,580.

b) Life Insurance. Currently life insurance is carried free of charge to the retiree by the company. Up to $10,000 is carried and anything less represents a loss. For me, the company will carry no free life insurance upon my life.

c) Hospitalization. A new policy with about half the current employee benefits can be carried at a cost of $27.62 per month, $331.44 per year, or $4971.60 to age 65.

d) Major Medical Expense. This coverage ceases with termination. A retired employee can carry the regular major medical expense at some nominal cost.

e) Loss on the sale of my home.

f) Increased cost of a new home and higher interest rates.

g) Social losses and intangibles lost by me and my family.

h) Cost and discomfort of an ulcer.

i) Loss on the liquidation of my family's personal business, which includes $9000 for the trade name, good will, etc., and an estimated inventory liquidation loss greater than $10,000.

j) Many other losses which I have not enumerated.

II. Technical Assessment

A. Purpose

No one ever explained to the students the purpose of the Environmental School. There were no goals defined and no rewards specified. Minimum expectancy was continued employment with a degree of job security. This expectancy, of course, proved fanciful.

B. Teachers

Certainly all of the teachers possessed a high degree of competence in their area of specialty. Some teachers had difficulty preparing a coherent and organized lecture. While some teachers adhered well to the class schedule, others insisted on long periods (1 1/2-2 hours) of uninterrupted class time. Needless to say, toward the end of these lectures it was nearly impossible to concentrate. One teacher (Burgess) was very well prepared and gave an interesting and organized lecture in 30-45 minutes with such clarity that a minimum amount of study time was required. Another teacher (Beall), while having an interesting topic, proceeded to cover so much territory that it seemed like "once over lightly."

C. Subject Material

1. Economics. I personally felt cheated with this course since the practical purpose was benefit-cost analysis. Many months of intensive study were spent on theory of the consumer, theory of the firm, etc. Overall, too much time was given to the subject, the examinations were complex and too long, and the questions were difficult to discuss completely to the instructor's satisfaction.

2. Energy in Society. The course contained a wealth of good material, but unfortunately was treated in a cursory manner. Much more time should have been given to nuclear power stations analysis, including more of the specific details of the various power reactors now being utilized. If the future of the LMFBR is as important as one is led to believe, then certainly a more intensive study of this reactor should have been warranted.

3. Meteorology. The material presented was very interesting, but more emphasis should have been placed upon application as it applied to projects that need environmental impact statements. The most interesting part of the course was solving the final problem set given as a take-home exam.

4. Hydrology. The material presented in this course was very interesting, but the time allotted to the instructor was entirely inadequate. It seems inconceivable that approximately 12 hours of class time would be allotted to cover an entire textbook of 328 pages which probably would normally be covered in an entire college academic quarter (3 months). The speed at which the instructor had to proceed to cover the material was ridiculous. The daily problems assigned were very practical and the examination was fair. I, myself, feel that I learned a great deal and would have liked to learn more.

5. Thermo-Hydraulics. This course could have been improved by at least doubling the time available. The area of thermo-hydraulics is rather new but extremely important in the analysis of industrial and nuclear discharges.

6. Ecology. The specific material was not too interesting, but the illustrative examples were terrific. The examples were practical and were presented in an easily understood manner. The teacher made the classes most interesting; in fact, I actually looked forward to them.

D. Overall Appraisal

I believe that everyone associated with the ORNL Environmental School was short-changed, especially the students. The students were asked and their families were required to sacrifice, yet most were rewarded by termination. Most students entered the School with high ideals and lofty thoughts that they were learning skills that would place them in a position of being in demand, not as a surplus commodity relegated to the proverbial scrap heap. The ORNL Staff Newsletter indicated the students would be assimilated into the environmental projects at the Laboratory. It is very surprising that the skills learned are not in demand at ORNL, the AEC, or in the marketplace. The AEC and ORNL have been short-changed in that their money has been spent training people who will never contribute to their organizations.

The School was haphazardly organized and poorly run. Whoever arranged the class schedule without considering the student work load would seem to be incompetent. Whoever was instrumental in selling the School to the students did them a grave injustice. Whoever ordered the termination of the students after the sell job certainly broke good faith and owes each of them a moral as well as an ethical obligation. I for one will never forget the injustice.

9. Ninth Student

The nine months I spent in attending the Environmental School were of considerable value to me and, in my case, I believe it will be of value to the Laboratory. I received an overall feeling for the U.S. energy picture and how this relates to the environment. My present assignment is to assist in the preparation of the Environmental Report for the LMFBR Program, and I have been able to help the other people on this program to understand the type of material that will be required for this report.

The staff for the School were unusually dedicated people. They prepared and presented their data in a manner far better than most of the teachers who have conducted classes that I have taken at the evening school at U.T. It is amazing that they were able to keep up their enthusiasm when so many of the students had been terminated.

Besides the direct effect of the instruction, the School forced me to improve my study habits and study discipline. These are of obvious value to my continuing education which is required for all persons in technical jobs.

I think the Laboratory would benefit by having all members of its staff go through such a school every few years. It would help keep the staff technically "young."

10. Tenth Student

The following is an appraisal of the School for Environmental Impact Statements. Twenty to twenty-five students attended the School for a period of nine months. Five students were supported by their "home" divisions, and the remainder were supported by Laboratory overhead (Director's Division).

1. Selection of Students. This was handled very poorly. Candidates were told to go to school or be fired. The public relations job was badly mishandled. The School could just as easily have been built up into something that at least presented a facade of respectability. As it was, our friends on learning of our "selection" greeted us in the hallways with condolences instead of congratulations.

2. Notification. We were given approximately ten days notice. In certain cases, people were allowed to spend their afternoons for 3-4 weeks finishing up their research. Obviously, not only were we considered expendable but so was our work.

3. Assignment to Impact Problem Areas. As the School was set up, a student spent half-time in formal lectures and half-time in actual impact writing in various problem areas. The students were not asked which problem area they would prefer working in but were simply assigned with the admonition that "considerable care and a number of considerations" were involved in the setting of assignments. Switching over to other areas was allowed in a few instances, however.

4. Class Attendance. Compulsory class attendance (to the extent that no vacation days were permitted during the nine month school term)

added to the generally repressive atmosphere. In light of the fact that most universities now make class attendance optional even for 18-year-old freshmen, it did seem a bit incongruous that a group of middle-aged technical people -- several holding Ph.D.s -- be ordered to show up for military style roll calls each morning.

5. Grading. Since attendance at this School was strictly involuntary and since no college credit was given, it would seem to have been an obvious place for the increasingly popular "pass-fail" system of grading. However, each instructor was ordered to give exams with number grades to be recorded in the student's permanent record. Several instructors voiced strong opposition but were told that this was the way it had to be -- period.

6. Instructors. Without exception, all six instructors were competent and conscientious. Their teaching ability ranged from adequate to very good. Course content was usually reasonable in light of the stated purpose of the School (training for impact statement work) but occasionally (meteorology and economics) was weighted too heavily in favor of basic principles.

7. Books. Textbooks were provided for each course along with a small library of reference books. The energy text was out of print when ordered and did not arrive until the course was half finished. An economics reference book was made required reading for two exams and an insufficient number of copies made it difficult for the entire class to read the book before the exams. The quality of the texts ranged from very poor to very good with most of them rating good.

8. Non-Academic Operations. The School was administered in an efficient manner. The secretarial assistance was outstanding in spite of unusual hardships (e.g., geographic remoteness from the main part of the Laboratory, poor copying equipment, etc.). Class schedules were distributed each week. Typing, copying, and other secretarial services were readily available and of high quality.

9. Historical Notes. In spite of the ego-shattering manner in which people were drafted into the School, an esprit de corps soon developed among the students which must have amazed even the most ardent supporters of the whole scheme. Such resilience could hardly have been expected from a group of people who reportedly were chosen because of their "lack of mobility and flexibility." Virtually every student put forth his best effort at least until "Black Friday" (February 16, 1973)

when 11 of the 15 people who were being supported by the School received termination notices. The small degree of respectability the School had gained by this time was totally shattered by this action. Here was a school set up for the explicit purpose of training twenty "highly competent scientists and engineers" to work on environmental impact statements. These were professional people who had, in many cases, spent their entire working careers (20 to 30 years) in specialized fields of research and engineering, who in many cases held advanced degrees acquired as a result of considerable personal effort and financial sacrifice, and who were now being removed from their life-long profession and told with ten days notice to go into an entirely new and unrelated field. Now, having accepted this turn of events and reaching the halfway point in their retraining period, they are told that the project for which they are being trained can only take two people and since there is no other support for them they are therefore fired.

Adding to the total absurdity of this turn of events was the requirement by the AEC on January 31, 1973 -- just two weeks before "Black Friday" -- that each student sign a contract to continue his employment for 13 months following the end of the school term or refund 4 1/2 months pay to Union Carbide!

10. Conclusions. It is certainly an enigma that even among those in responsible positions in the ORNL environmental impact project the School is considered to be more a liability than an asset. As one ORNL environmental impact project leader put it, "that School was a disaster" -- totally losing sight of the fact that along with being a disaster in terms of continued employment at ORNL, it was also a unique, top quality training experience for people going into managerial positions in the environmental impact field. Thus, the real value of the School was and is totally obscured by the dark cloud which hung over it from its very inception. For those who survived the terminations, the stigma associated with having been a part of the Environmental School is something they must try hard to live down.

On the positive side, of the fifteen people completing the School, at least five will be working in the environmental field -- two at ORNL and three elsewhere. Job hunting for the others, hopefully, will be easier for having had this training.

D. The Environmental Impact Reports Project

1. Thomas H. Row, Deputy Director of the Environmental Impact Reports Project

I contacted the Task Group Leaders to request their appraisal of the students from the Environmental School. In some cases, the evaluation was the result of having one or more students working directly with a Task Group in preparing draft material for a statement, in other cases observations of students who were personal friends. The statement is a summary of these remarks.

Students were used in several capacities in the Environmental Impact Reports Project. The Project was established in March 1971 to assist the Commission in completing the environmental analyses of nuclear power plants. Following the Calvert Cliffs decision, the Project size was greatly increased and involved more than seventy ORNL staff members in FY 73. Students were used to supplement this existing task force of personnel. Some were assigned to a task group and given responsibility for drafting a section of an environmental statement while other worked on generic problems.

The School provided the students with a broad background that enabled them to appreciate the many problems associated with impact analyses. However, it is not possible to say that retraining was completely successful. In most cases, it was necessary to place an individual in a job situation fairly closely related to his original profession to obtain optimum performance. For example, none of the students became proficient in ecological science to the point that they could serve as a task group lead ecologist.

In scattered cases, some students found a niche where they were able to develop a skill to the point that they ultimately found a job in industry as a result. Cost/benefit evaluations and cooling tower drift predictions are typical examples of specialties where individuals concentrated their training.

As in any training program, the students that applied their abilities in a positive fashion received the most benefit. The Project hired two of the students for permanent assignment.

2. R. P. Wichner, Thermal Hydraulics Group

a. Meteorology and plume behavior lectures by Frank Gifford were an excellent preparation for impact statement work. In short order, the four students became our "experts" in this field, and if some continuity had been achieved, there would have been a good basis for an R&D program, including: 1) improved methods for fog prediction, 2) standard methods summary for general use in impact statements, 3) fog predictions re: cooling ponds - now highly sketchy, and 4) icing predictions - now extremely sketchy

b. Lectures on thermal dispersion in water were extremely weak. The concentration seemed to be on "hydrology" rather than mass and heat transfer in plumes. Perhaps a general class, such as this was, would not be capable of specializing to the extent needed for contributing to thermal dispersion work for impact statements. Yet, this was in fact done in the atmospheric dispersion area.

The thermal dispersion lectures were not well thought out with respect to either preparing for thermal impact judgments for impact statements or for basic understanding of mechanisms.

c. Student attitudes: The four students in the thermal impact area maintained excellent work attitudes even after three of them received termination notices. This was true down to at least three to four weeks from their scheduled departure dates. Two of the four began to perform original work, which was, of course, left incomplete -- one in the area of fog predictions, the other in the area of predicting biological entrainment at oceanic sites.

In sum, the four students contributed significantly to the thermal hydraulics effort in the brief span that they were associated with it. In fact, since manpower was so short, the student contribution was an essential and significant portion of our total effort.

d. General comments on curriculum: Probably, actual members of the impact statement projects should have been consulted regarding the contents of the curriculum. I don't believe they were, and as to why this should be the case escapes me. Certainly, consultation with project members would be a prerequisite for the stated objective of turning out students capable of working in the project. Otherwise, a lot of extraneous stuff gets thrown in and important areas are omitted -- as was the case.

e. The use of students for menial tasks was quite objectionable. Students should not be made to perform literature surveys or other such menial jobs -- drawing graphs, making up tables, etc. They are, by and large, graduate engineers and scientists and should be challenged accordingly.

f. Concluding remarks: Perhaps the stated objectives of the School's program were too general -- "to provide workers capable of writing impact statements." This tends to lead to a lot of generalized material, which may easily be picked up by interested people on their own. The objectives perhaps should have been focused more on the technical and scientific aspects of problems encountered in impact statement evaluations. The highest technical level should have been striven for, even to the extent that the lectures would not be immediately "applied," but a good grounding in the basics would be attained. The trade school approach should be shunned, basic science aspects emphasized.

The Environmental School in this respect was different from the Reactor School where an exacting degree of technical competence was demanded and where the curriculum was developed around basic science and technology. Probably, it would have been best if the Environmental School had adopted this approach.

3. D. J. Nelson, Biological Environmental Impact Group

The Environmental Sciences Division participated in the Impacts School as one of the divisions where school participants gained practical experience. Most of the participants I had contact with were eager and enthusiastic workers. However, the work we could assign them to do independently should be described as limited. None of the students had the necessary background to understand the work they were doing. Some of them had elementary biology in their background, but this course material was taken many years before and there was little retention of the material. Further, their previous educational experience bore little relevance to the environmental evaluations we are required to do. The students were used mainly as "leg men" to round up material needed for impacts assessments. Attempts to encourage them to synthesize data from the technical ecological literature were generally unsuccessful, mainly because the students lacked the background to understand the processes involved. We maintained a continuing effort to involve the students in significant aspects of the reactor station evaluations with a tutorial approach. The results of our efforts were not generally successful in a meaningful way.

We ran into another problem in the School because of our stance that the students should gain some practical working experience. The students were placed in a competitive situation in their class work. According to the stories we received, students assigned to other Laboratory divisions were able to use "work" time to study lessons. Our assigned students felt they were being placed in a poor position with respect to other students in the School. I could only agree with them, but this did not change our position with respect to work.

I feel our staff members made a serious effort to retread other scientists to write impact statements. These efforts were of limited value because of (1) the lack of appropriate background of the students, and (2) a morale problem created by non-uniform treatment of students in the various Laboratory divisions.

4. H. E. Zittel, Effluent Systems Group

I worked with one student during his attendance at the School. His half-time was spent working on chemical and radwaste effluents. He was very capable and, with his background, had little difficulty with the technical aspects of these sections of an impact statement. However, it was very apparent to both of us that classroom lectures could not take the place of practical experience and, for that reason, felt that the mixture of classroom and working experience was of great benefit to him. It was my understanding that this admixture was a large plus for him in obtaining his position with a nuclear power facility since he was able to demonstrate working knowledge. Since he left the Laboratory, he has indicated several times that his total School experience has been of great use to him.

# APPENDICES

# APPENDIX 1

## Notes on Meeting of Advisory Panel for In-House Education Program in Environmental Sciences and Ecology - December 13, 1971

An advisory panel has been assembled to consider an in-house education program in Environmental Sciences and Ecology. Members are H. I. Adler, S. I. Auerbach, F. R. Bruce, C. C. Burwell, M. L. Nelson, J. L. Liverman, R. S. Livingston, J. S. Olson, F. Plasil, and H. W. Schmitt. Ex-officio members are: A. M. Weinberg and F. L. Culler, Jr.

The education program in Environmental Sciences and Ecology is envisioned to be the first part of a broad, long-range in-house education program, a preliminary outline of which is attached for your reference. Your comments and suggestions on this outline separately would be most welcome.

The advisory panel had its first meeting on December 13, 1971. The question of objectives for such a program was discussed at length. The following points were generally agreed to contain at least an initial set of objectives, applicable at professional levels:

1. To provide a supply of highly competent scientists and engineers, trained in the fundamentals of environmental sciences and ecology, who can then enter those fields in professional capacities.

2. To strengthen the environmental sciences and ecology programs at the Laboratory by the addition of scientists and engineers of diverse backgrounds.

3. To provide a mechanism whereby capable scientists and engineers may change their fields of specialization into ecology or environmental sciences. (This point may be appropriate for those whose current work within the Laboratory may possibly be discontinued or no longer funded.)

4. To provide a mechanism whereby scientists and engineers may become familiar with ecology and environmental sciences, even though they do not enter these fields professionally. (This point could be appropriate for those who work in support of these fields, or for whom it may be desirable to become familiar with these fields.)

A number of other aspects of the proposed program were discussed, and a consensus was reached on the following points:

1. The program is to serve in-house professionals. Ties with universities, ORAU, etc., or with any degree-granting program are not presently envisioned, but may develop after the program gets underway. University professors or other outside consultants may be used as instructors.

2. The level of excellence is to be kept high among the professionals who enter this program. Public relations are to be conducted so that it is clear that mobility is desirable and that this is a desirable program with professionals hand-picked to participate.

3. This program will contribute to the strengthening and vitality of the staff, as well as to staff mobility. We should keep in mind the possibility of part-time participation in a few cases where that might be desirable.

4. Longer range, we may wish to set up a program analogous to this one at technician and support levels. This is a point to keep in mind but is not an immediate objective.

5. We may also wish to consider setting up courses of instruction which would be available to the staff on a part-time and/or extra-curricular basis, as is done, for example at Bell Labs. A staff member could then become familiar with the environmental sciences or ecology while he continues his current professional work, thereby becoming more effective if his work is related to those fields, or testing his interest if his work is not related to them.

Initial steps in establishing the proposed program include designing and setting up a curriculum, arranging for faculty, arranging for classroom space, and eventually, choosing the first candidates for participation. The optimum degree of on-the-job training is to be sought.

The Planning Group will work with members of the Advisory Panel and other appropriate Laboratory staff members to carry out these steps, in order to begin the program as soon as possible.

## ORNL Program for Advanced and Continuing Education

### General

The Laboratory is becoming more deeply involved in a number of new areas, many of which are interdisciplinary in nature. Staffing in these new areas, as their activities increase, will be principally from within the Laboratory and, therefore, will entail certain career reorientations among the present staff.

In addition, Laboratory management wishes to encourage mobility of the professional staff. It is well known that a scientist who is highly competent and creative in one area is very likely to be competent and creative in another area in which he becomes interested. Evidence indicates that, for many scientists, occasional changes in specialty area (so that several such changes occur during one's working lifetime) maintain vitality and interest at highest levels.

It is therefore the desire of Laboratory management to set up an in-house education program. The program which is envisioned -- let us temporarily call it PACE, Program for Advanced Continuing Education -- is to be designed to provide high-quality education and study, particularly in new areas, for the Laboratory staff, i.e., professional study for professionals.

The broad objectives of PACE, as presently seen, are as follows:

1. To provide highly competent scientists and engineers with the fundamentals of a new area, in a reasonable and efficient manner, so that they may become active, contributing staff members in that area.

2. To provide courses whereby scientists and engineers may become familiar with a new area, i.e., to broaden their backgrounds and outlooks, even though they do not enter the new field professionally.

3. To provide increased mobility and skills among the staff and, thereby, to increase long-term staff effectiveness and flexibility.

PACE will provide a framework within which a curriculum in any desired area can be made available to the Laboratory staff. The duration and scheduling of a typical study program will be optimized according to the particular area concerned; if an ORSORT model is followed, for example, the term may be 9 to 12 months, with full-time participation by enrollees. PACE will be an in-house program, initially without ties to universities or other institutions, although particular individuals from universities or elsewhere may be employed as instructors.

Long-term, it is anticipated that PACE will include courses of instruction, particularly in new areas, available to the staff on a part-time and/or extra-curricular basis. Such an activity would permit a staff member to broaden his background and knowledge and, perhaps, to test his interest in an area which he is considering for possible professional involvement.

PACE may also eventually include refresher courses and advanced courses in the disciplines represented in the Laboratory. Some courses could be tailored to undergraduate level, non-scientific, and support personnel.

The first new, interdisciplinary area in which a PACE curriculum is being considered is that of Environmental Sciences and Ecology.

APPENDIX II

**OAK RIDGE NATIONAL LABORATORY**
OPERATED BY
**UNION CARBIDE CORPORATION**
NUCLEAR DIVISION

POST OFFICE BOX X
OAK RIDGE, TENNESSEE 37830

OFFICE OF THE DIRECTOR

April 28, 1972

Mr. Robert J. Hart
U. S. Atomic Energy Commission
Post Office Box E
Oak Ridge, Tennessee 37830

Dear Bob:

We have been giving thought to what we might do in a systematic way to increase the effectiveness of the Laboratory staff. This is a continuing management objective, but it has heightened importance today because our programs are changing rapidly and staff turnover is low. In this connection, we hope to implement this fall a full-time educational program to retrain a segment of the technical staff in fields where our programs are growing. The attachment describes the general program and the first year's activities. Specific activities for subsequent years would be developed as needed.

The full-time program includes two curricula - one emphasizing the environmental effects of technology and the other pointed toward producing physical scientists conversant in the fields of biology and ecology. Each program consists of about half-time for classroom work for a calendar year combined with a half-time, on-the-job training on a related technical project. About 20 staff members would participate in the full-time program.

In addition to the full-time program, we will offer special courses that would be of value to the staff in their present assignments. The initial special course offering will be in economics.

As presently envisioned, the courses would not earn college credit, and would not be coordinated with any particular university. Teachers would come in part from the ORNL staff. The annual cost for teacher salaries and physical facilities will be about $100,000 (see the attachment for budgetary details).

The primary objective of the program is to improve our internal vitality and mobility by equipping staff members to be effective in fields that are increasing in importance - e.g., preparation of environmental impact statements. A secondary result may be that participants would have enhanced opportunities outside the Laboratory as a result of their involvement in the program. Carrying the idea a little further, if it were felt that the educational program would be of value to non-ORNL participants, we could try to accommodate their needs as well.

May we have your comments on our plans?

Sincerely yours,

Alvin

Alvin M. Weinberg

AMW:pl

cc: Elliot S. Pierce
H. I. Adler
S. I. Auerbach
J. A. Barker
D. S. Billington
F. R. Bruce
R. F. Hibbs
J. L. Liverman
R. S. Livingston
R. A. McNees
Lewis Nelson
H. W. Schmitt
A. H. Snell
D. B. Trauger

Attachment

Attachment

# STAFF EDUCATION PROGRAM AT ORNL

## INTRODUCTION

In recent years ORNL has become involved in several new areas of research while support in certain traditional areas has declined. Staffing in the new areas has come to a large extent from within the Laboratory, and this trend is likely to continue in the foreseeable future. While such a pattern is desirable in that it helps to provide jobs for scientific personnel from areas of decreased funding, there is not always a good match between individual skills and those required in the new field. Thus, for example, while a chemist may be useful in an environmental program, he would be even more valuable if he were familiar with the fundamentals of ecological sciences.

Another important problem at ORNL is the general question of vitality of professional staff. While this is not a new problem, it becomes increasingly more acute as the average age of the staff increases. Internal mobility of professional staff members contributes to maintenance of vitality. A scientist who is competent and creative in one area is likely to be competent and creative in another area in which he becomes interested, and for many scientists occasional changes in specialty area maintain vitality and interest at highest levels. But even in those cases where individuals do not enter a new field professionally, vitality is stimulated by the broadening of outlook resulting from exposure to a different area or discipline. Based on these considerations, we propose a comprehensive staff education program at ORNL.

## OBJECTIVES

1. To provide highly competent scientists and engineers with the fundamentals of a new field so that they may become active contributing staff members in that field.

2. To stimulate internal mobility, and make internal mobility attractive.

3. To provide an opportunity for staff members to acquire expertise in a field other than their own which they may need to carry out their duties effectively (for example, many engineers and scientists would benefit from a course in economics).

4. To provide an opportunity for staff members to broaden their outlooks through exposure to new fields even though they may not enter those fields professionally.

5. To provide undergraduate level "refresher" courses for individuals who wish to brush up on old skills or for purposes of self-development at the support personnel level - e.g., technicians.

## STRUCTURE

We propose two separate programs to meet the above objectives:

a. Full-time specialized programs, and

b. part-time continuing programs.

Full-time specialized programs will be designed to meet objectives one and two above. Their primary purpose will be to help in the reorientation of staff members who wish to enter new fields of research. The duration of any particular program will probably be of the order of one year. The programs will be coordinated with on-the-job training; students will spend about half of their time participating in course work and the other half assigned to a research group in their new field.

Part-time continuing programs should meet objectives three to five above. We propose to establish a program similar to the one in effect at Bell Laboratories. Each course will involve at least one session per week on ORNL time. Some courses will be taught by Laboratory staff members, others by outside consultants.

## FULL-TIME SPECIALIZED PROGRAMS

These programs will provide training for highly competent scientists and engineers who wish to reorient their careers and work in areas of expanding activity at ORNL. The expanding areas of research being considered at this time are the environmental sciences. We consider it important to launch these programs as soon as possible since the mobility which they will stimulate may help to relieve pressures created by budgetary restrictions in certain areas of research. It is important to stress, however, that we wish to involve individuals of high competence and motivation. This program is not designed to solve the problems of marginal professional performance.

The format for the full-time specialized programs described below is tentative, and may change as the curricula are developed. Each program will involve a number of full-time participants, and will last about one year. About half of a participant's time will be taken up with formal course work, while the other half will consist of on-the-job exposure to the new chosen area of activity. Thus needs at ORNL must be established - e.g., projected vacancies in the Environmental Sciences Division - and individuals should be assigned to the projected openings. Participants would not only learn the basic foundations of their new field, but they would also be exposed to practical problems and methods of their prospective new careers. No commitments would be required with regard to any individual continuing in any particular job after his completion of the full-time program. It is hoped that after completing the program in ecology the participant will be a competent physical scientist or engineer (not an ecologist) who is knowledgeable in the general field of ecology and who is familiar with frontier research methods in a particular ecology sub-field. In addition, he would also be familiar with the general programs of the ORNL Environmental Sciences Division.

## EDUCATIONAL PROGRAM FOR THE 1972-73 SCHOOL YEAR - ENERGY AND THE ENVIRONMENT

### Full-time Specialized Program in Ecology

A one-year program (half-time on the job) to provide additional personnel primarily for the ecological activities within the Environmental Sciences Division. Participants will come largely from the physical science divisions. The intent is to produce professionals who are conversant in the fields of biology and ecology. Courses would be taught with a strong slant toward the current "environmental awareness" and related programmatic work at ORNL.

### Full-time Specialized Program in Environmental Effects

A one-year program (half-time on the job) to provide additional personnel for preparing environmental impact statements and perhaps for the ORNL-NSF Environmental and/or ORNL-RANN Programs. Participants will come primarily from the physical science divisions. The intent is to provide a general background of information on environmental effects of technology - e.g., type, source, control, movement, measurement, and effect of effluents from central power stations.

### Part-time Continuing Program

A one-year course would be offered to initiate a continuing education program at ORNL. Participants would be selected from the staff at large, based on the value of the course to the individual on his current or prospective program assignment. The first offering would be a two-unit, two-semester course in economics as related to project appraisal and technology assessment.

### Curricula for Full-time Specialized Programs

#### Ecology

| First Semester | Second Semester |
|---|---|
| Biology (4 units) | Biology (2 units) |
| Economics (2 units) | Ecology (2 units) |
| Special Topics (2 units) | Special Topics (4 units) |

## Environmental Effects

**First Semester**

Ecology/Biology (2 units)

Movement of Air and Water (2 units)

Economics (2 units)

Energy in Society, Central Power Station Characteristics (2 units)

**Second Semester**

Ecology/Biology (2 units)

Environmental Chemistry, Effluents and Their Impacts (2 units)

Special Topics (4 units)

## Course Contents

Ecology/Biology (2 or 4 units, Semesters 1 and 2)

Principles and concepts of ecology: characteristics of populations of plants and animals (including man); structure and functioning of biological communities; biogeochemical cycles; energy and productivity in ecological systems; marine, fresh-water, terrestrial, and estuarine ecology; systems ecology; pollution; principles of measurement in ecology. Principles of biology and their application to ecology: microbiology of air, water, and wastes; terrestrial and aquatic zoology; botany; aerobic and anaerobic oxidation; biodegradation of organic compounds; metabolism of nitrogen and sulfur compounds; biosynthesis; enzymology; radiation biology; radiation ecology.

Movement of Air and Water (2 units, Semester 1)

Meteorology and atmospheric phenomena, atmospheric circulation; gaseous and particulate air pollutants and their dispersal; thermal pollution and plume modeling. The hydrological cycle: precipitation, evapotranspiration, geology, and the movement of ground water; water pollutants and their dispersal. Detection and measurement of air and water pollutants; standards.

Economics (2 units, Semester 1)

Principles of economics: time value of money, cash flow analyses, present worth analysis, opportunity cost of capital, multi-purpose project cost allocation and cost/benefit analysis, interchangeability of capital, labor and materials, fixed charge rate, taxation, inflation, equity capital, risk analysis, external costs and benefits, real interest rate, foreign exchange.

Environmental Chemistry, Effluents and Their Impacts (2 units, Semester 2)

Application of organic, inorganic, physical, and analytical chemistry to environmental measurements, including pollution measurements; pollution control, abatement, and effects.

Energy in Society, Central Power Station Characteristics (2 units, Semester 1

Energy in society: uses, forms, by-products of production and use, efficiency of use, fuel resources, technology and economics of alternative sources, transport, storage, seasonal requirements. Central power station characteristics: nuclear and fossil fueled power plant designs and cycles of operation; power transmission; fuel supply, fabrication and reprocessing; chemical effluents; alternative cooling system costs and effects; radioactive waste management.

Special Topics (2 units, Semester 1)

Topics to be taken largely from special courses given in the Environmental Effects program that are not given in the Ecology program: Movement of Air and Water; Environmental Chemistry; Effluents and Their Impacts; Energy in Society; Central Power Station Characteristics.

Special Topics (4 units, Semester 2)

Topics are to be determined; one or more lecture-discussion sessions on topics such as the following are envisioned: Forestry and forest conservation; Agricultural resources and projections; Mineral resources and projections; Resource use analysis and recycling; Urban environmental problems; Waste treatment and disposal; Technological assessment; Societal forces and environmental problems; Environmental law; Governmental agencies and their functions; Non-governmental organizations and their roles.

## Selection of Participants

Participants would come from the following three sources: (1) direct interest of prospective candidates; (2) suggestions from division managements; and (3) suggestions from the proposed "mobility coordinator".

A small committee will consider the list of candidates and make the final selection.

Item one above is intended to take advantage of self-motivation. Direct applications from the staff will be encouraged. To stimulate interest, it is necessary to widely publicize the educational venture and present it as a desirable option.

Item two takes care of line-management input. Division directors could, for example, encourage some of their staff members to participate in the program.

Item three refers to a "mobility coordinator" who will be appointed to handle general staff mobility problems. One of his functions should be to identify individuals who would most benefit from the educational program, and to get them interested in participating.

A small committee of about five members, which could include management and staff representatives, will be charged with narrowing down the list of potential candidates.

## BUDGET

| | | |
|---|---|---|
| <u>Salaries</u> | | |
| Director and Staff | 3.0 MY | $64,800 |
| Secretarial | 1.0 MY | 6,000 |
| <u>Consultants</u> | | |
| Teacher, part-time, Vanderbilt, 20 days at $100 per day fee + $50 travel/per diem | | 3,000 |
| Miscellaneous consultants - 10 consultants five days each at $100 per day fee | | 5,000 |
| $250 each trip - per diem and travel | | 2,500 |
| <u>Miscellaneous</u> | | |
| Computing | | 2,000 |
| Supplies and equipment | | 4,000 |
| Rent/maintenance - building | | 12,000 |
| TOTAL | | $99,300 |

APPENDIX 3

# INTRA-LABORATORY CORRESPONDENCE

OAK RIDGE NATIONAL LABORATORY

May 31, 1973

To: Robert S. Livingston

From: C. C. Burwell

Subj: Internal Market for the First Year's Graduates from the Proposed In-house Educational Program for ORNL

## Discussion

I discussed the availability of permanent jobs within ORNL for the first year's graduates from the proposed education program with Adler, Auerbach, Beall, Gibbons, and Struxness. I was not able to arrange a meeting with Anderson. The discussions were based on the assumptions that the receiving program or division would pay for the students for the half-time spent in on-the-job training on their activities and provide full-time support for acceptable graduates. It as also understood that the general quality of the Laboratory employees entering the educational program would be at least average.

Adler and Auerbach are willing to accept two graduates each on a permanent basis. The students would also complete their half-time on-the-job training in the Biology and Environmental Sciences Divisions.

Beall would prefer graduates with training in reactor engineering but will accept two to four graduates from the educational program depending upon their qualifications.

Gibbons feels he cannot make a firm commitment to support additional staff at this time. However, if consistent with future program funding, he could use an engineer and a biologist schooled by the educational program.

Struxness says that since the EIS activity is a program rather than a division he cannot make commitments to provide permanent staff positions. In addition, his experience thus far suggests that few, if any, individuals would be satisfied with a permanent assignement in preparing EISs. Since many of his present EIS staff are anxious to return to their home divisions, he feels he could easily absorb the entire class for their half-time on-the-job assignment or alternatively provide half-year employment for a constantly rotating group as long as the EIS activity is funded. According to McNees, the EIS activity is currently running at an annual level of $2.75 million (70 technical man-years) and is expected to stay at that level through FY 73.

It is logical to predict that some fraction of the participants in the EIS program would recognize new ideas for research as a result of their EIS involvement. A mechanism for converting these ideas into proposals should be provided. Thus, a few school graduates with on-the-job training in the EIS program could be placed for a few months period with the Planning Group or the NSF Environmental Program in order for them to develop their ideas.

Summary

| | Probable Placement for Assumed First Year Group of 20[a] | | |
|---|---|---|---|
| | Half-time during school year | Permanent upon graduation | Temporary upon graduation |
| Biology Division | 2 | 2 | 0 |
| Environmental Sciences Div. | 2 | 2 | 0 |
| Reactor Division | 2-4 | 2-4 | 0 |
| NSF Environmental Program | 0 | 2 | 2[b] |
| EIS Program | 14-12 | 0 | 10-8[c] |
| Total | 20 | 8-10 | 12-10 |

[a]Ten each in the "Ecology" and "Environmental Effects" curricula.

[b]Or in the Planning Group to develop ideas.

[c]i.e., the rest of them.

Conclusion

There would seem to be little risk proceeding.

# APPENDIX IV

## PROFILE OF THE ENVIRONMENTAL SCHOOL

A. Students

| Name | Original Division | Age | Highest Degree | Field |
|---|---|---|---|---|
| Boston, C. R. | M&C | 45 | Ph.D. | Physical Chem. |
| Burwell, C. C.* | Director's | 43 | M.S. | Nuclear Eng. |
| Busey, R. H. | Chemistry | 54 | Ph.D. | Physical Chem. |
| Cuneo, D. R. | M&C | 52 | B.S. | Physical Chem. |
| Fitzpatrick, Frances | Gen. Eng. | 45 | B.A. | Engineering |
| Fleischer, B. | M&C | 42 | M.S. | Metallurgy |
| Glover, I. T.* | ORAU | 30 | Ph.D. | Chemistry |
| Guberman, H. D. | Solid State | 43 | Ph.D. | Chem.-Metallurgy |
| Kegley, T. M. | M&C | 50 | M.S. | Metallurgy |
| Kirslis, S. S. | Reactor Chem. | 53 | Ph.D | Chemistry |
| Mackey, T. S. | Isotopes | 53 | B.S. | Chemical Eng. |
| Mahlman, H. A. | Chemistry | 50 | M.S. | Chemistry |
| McBride, J. P. | Chem. Tech. | 55 | M.S. | Physical Chem. |
| Moore, G. E. | Chemistry | 51 | Ph.D. | Chemistry |
| O'Donnell, F. R. | Isotopes | 36 | M.S. | Physics |
| Rainey, R. H.* | Chem. Tech. | 56 | B.S. | Chemistry |
| Roddy, J. W. | Chem. Tech. | 42 | Ph.D. | Chemistry |
| Rutherford, J. L. | Reactor Chem. | 42 | B.S. | Math. |
| Sturm, B. J. | Chem. Tech. | 47 | B.A. | Inorganic Chem. |
| Vaslow, F. | Chemistry | 54 | Ph.D. | Physical Chem. |

*Audited one or more courses.

B. Staff

| Name | School Assignment | ORNL Position |
|---|---|---|
| S. E. Beall | Energy in Society | Director, Reactor Division |
| R. L. Burgess | Ecology | Ecologist, Program Director, Env. Sci. Div. |
| J. A. Duguid | Hydrology | Senior Staff Member, Env. Sci. Div. |
| F. A. Gifford | Meteorology | Director, Atmospheric Turbulence and Diffusion Lab., NOAA |
| G. S. Gill | Economics | Consultant |
| L. Nelson | Director | Director, Office of University Relations |
| P. J. Ryan | Thermal-Hydraulics | Head, Thermohydraulic Group, Env. Sci. Div. |

Staff (cont)

| Name | Previous Teaching Experience |
|---|---|
| S. E. Beall | Frequent invited lectures |
| R. L. Burgess | Instructor at U. of Wisconsin, Arizona State, and North Dakota State Univ. - 1955-1970; taught 1 year at Pahlivi Univ., Shiraz, Iran |
| J. Duguid | Univ. of Wyoming, 1964-1968 (Dept. of Civil Engineering) |
| F. A. Gifford | Taught Meteorology and Atmospheric Turbulence at Univ. of Tennessee, Vanderbilt Univ. for last two years |
| G. S. Gill | Taught economics at Univ. of Tennessee, taught in departmental school at laboratory in India |
| L. Nelson | Director and Instructor, ORSORT, 1950-1965 |
| P. J. Ryan | MIT - 2 years as teaching assistant in fluid mechanics |

C. Half-Time Assignments in the Environmental Impact Reports Project

1) With the Thermal-Hydraulics Group under R. P. Wichner - four students

2) With the Biological Environmental Impact Group under D. J. Nelson - five students

3) With the Cost/Benefit Analysis Group under R. M. Hill - four students

4) With the Site and Environs Group under R. H. Bryan - two students

5) With the Effluent Systems Group under R. R. Rickard - one student

6) Working independently on Generic Reports - one student

D. Costs and Funding

All of the costs of the Environmental School were borne by the overhead account.

| | |
|---|---|
| Salaries of faculty, director, and secretary | $ 35,000 |
| Salaries of students* | 209,000 |
| Materials | 11,000 |
| | $255,000 |

*Does not include salary of student from ORAU.

E. Curriculum and Course Lists

Listed below are the courses, instructors, scope, total number of lectures (usually 1 to 1 1/2 hours each), and the texts used. The complete course list follows.

Ecology - Robert L. Burgess - 52 lectures and a field trip

E. J. Kormondy, Concepts of Ecology
R. H. Whittaker, Communities and Ecosystems

Economics - G.S. Gill - Cost Benefit Analysis and Microeconomics background to it - 46 lectures

C. E. Ferguson, Microeconomic Theory
P. W. Barkley and D. W. Seckler, Economic Growth and Environmental Decay
O. Eckstein, Water Resource Development, Harvard University

Energy in Society - Sam E. Beall, Jr. (Director, Reactor Division) and 20 invited outside speakers - history of energy utilization, survey of resources, modern power plants, promising future sources of energy - 40 lectures and 2 field trips to power plants - H. C. Hottell and J. B. Howard, New Energy Technology-Some Facts and Assessments, M.I.T.

Hydrology

James A. Duguid - Basic Civil Engineer's Course - 16 lectures
R. K. Linsley, Jr., et al., Hydrology for Engineers

T. Tamura - Sediments and Their Reactions - 3 lectures

Patrick J. Ryan - Cooling Systems, Heat Transfer - 10 lectures
D.R.F. Harleman, et al., Engineering Aspects of Heat Disposal from Power Generation, M.I.T.

Meteorology - Frank A. Gifford, Jr. (Director, Atmospheric Turbulence and Diffusion Laboratory) and Steven R. Hanna - emphasizing atmospheric diffusion of pollutants - 36 lectures

U.S.A.E.C., Meteorology and Atomic Energy 1968
G. A. Briggs, Plume Rise, U.S.A.E.C.

# ECOLOGY

## Unit 1

| Week | Subject |
|---|---|
| 1 | Introduction; Definitions; Scope of the course. |
| 2 | Basic biology; Subdivisions of biology; plant and animal phyla; Systematics and evolution. |
| 3 | Important biological processes; Photosynthesis and respiration, etc. |
| 4 | Environment; Abiotic and biotic aspects. |
| 5 | Nature of communities; Structure. |
| 6 | Nature of communities; Function. |
| 7 | Energy flow; Fixation by autotrophs. |
| 8 | Energy flow; Utilization by heterotrophs. |
| 9 | Production; Measurement; terrestrial and marine. |
| 10 | Production; pyramids, efficiencies, management. |

## Unit II

| | |
|---|---|
| 1 | Cycles in ecosystems; Nature and kinds. |
| 2 | Hydrologic Cycle. |
| 3 | Biogeochemical cycles; Nitrogen. |
| 4 | Biogeochemical cycles; Major and minor nutrients. |
| 5 | Population ecology; Animals. |
| 6 | Population ecology; Plants |
| 7 | Ecosystem dynamics; Succession. |
| 8 | Ecosystem dynamics; Population characteristics. |
| 9 | Ecology and man. |
| 10 | Ecology and man. |

# ECONOMICS

| Section | Subject | Duration (weeks) |
|---|---|---|
| 1 | Introduction to Economics | 1/2 |
| 2 | The Theory of Consumer Behavior | 3 |
| 3 | The Theory of the Firm | 3 |
| 4 | Market Equilibrium | 2 1/2 |
| 5 | A Cursory Survey of Imperfect Competition | 1 |
| 6 | Introduction to Welfare Economics | 2 |
| 7 | Optimization Over Time | 1 |
| 8 | Theoretical Foundations of Cost-Benefit Analysis | 2 |
| 9 | Case Studies (illustrating the writing-up of the environmental impact statements) | 3 |

# ENERGY IN SOCIETY, CENTRAL POWER STATION CHARACTERISTICS

| Session No. | Subject | Speaker |
|---|---|---|
| **I. Energy Consumption Patterns** | | |
| 1 | Consumption Patterns<br>(a) Transportation, Residential, Commercial Industrial, Electrical Generation<br>(b) Fractions of Each Energy Source for Each Use<br><br>Projected Demands<br>(a) By Source of Fuel<br>(b) Electrical - Consumption and Capacity Geographic Distribution | Beall |
| **II. Resources** | | |
| 2 | Coal<br>Oil<br>Gas | Beall |
| 3 | U-Th<br>Li-$D_2$<br>Water<br>Wind, Tides, Waves<br>Biological - Solid Waste (Burn, Ferment) Crops<br>Solar - Thermal, Direct (Earth, Satellite) Ocean $\Delta T$<br>Geothermal - Wells, Stimulated, Conversion Systems | |
| 4 | Quiz | |
| **III. Preparation for Use of Resources** - Emphasizing Environmental Effects and Total Social Costs (Quantities Dedicated for 1000 MWe Plant) | | |
| **A. Extraction** | | |
| 5 | Petroleum, Natural Gas, Oil Shales, Tar Sands, Uranium-Thorium | Beall |
| 6 | Coals: Deep and Surface Mining - Spoils, Acids Drainage, Reclamation, Accidents, Epidemiological | Nephew |

| Session No. | Subject | Speaker |
|---|---|---|
| B. | Processing | |
| 7 | Coal, Lignite - Gasification<br>Coal - Liquefaction<br>Petroleum - Refining, $SO_2$ Removal, Gasification | Milford-<br>Beall |
| 8 | Oil Shale, Tar Sands, Natural Gas | Beall |
| 9 | Uranium Ore, Treatment, Refining<br>Thorium, Enrichment | Crouse |
| 10 | Fuel Processing Plutonium Fabrication | Blanco-<br>Lotts |
| C. | Transportation - Truck, Rail, Ship, Pipeline | |
| 11 | Coal, Petroleum Products, Natural Gas, LPG,<br>Uranium - Thorium (Spent) Plutonium (Spent) | Beall-<br>Shappert |
| 12 | Quiz | |
| IV. | Site Location and Preparation - Environmental, Economic and Social Impacts | |
| 13 | Requirements - Access to Supply, Nearness to Load,<br>Cooling, Aesthetics, Discharges, Dual Purpose,<br>Special Nuclear | Beall-<br>Yarosh |
| 14 | Preparation, Structures, Roads<br>Construction Organization, Schedules | Beall-<br>Yarosh |
| 15 | Power Parks, Single Station, Neighborhood<br>Inland, Coastal, Offshore, Underground | Beall |
| 16 | Field trip to Sequoyah | |
| 17 | The Electrical Utility Industry - Organization:<br>Distribution, Size, Function, Public, Private,<br>Funding, Rates | Beall |
| 18 | Cycles (Carnot, Brayton, etc.) | Robertson |
| 19 | Power Station Design | Robertson |
| 20 | The Electrical Utility Industry - (continued) | Beall |
| 21 | Cooling - River, Lake, Ocean, Wet, Dry Towers -<br>Costs, Effects | Bowers |
| 22 | Thermal Modeling, Intakes, Outfall, Distributors | Wichner |

| Session No. | Subject | Speake |
|---|---|---|
| 23 | Quiz | |
| 24 | Trip to Bull Run Steam Plant | |
| **V. Reactors** | | |
| 25 | PWRs | Briggs |
| 26 | BWRs | Bryan |
| 27 | LMFBR | Harms |
| 28 | AEC Regulatory and Environmental Impact Statements | Struxne |
| 29 | HTGRs | Kasten |
| 30 | Nuclear Safety | Beall |
| 31 | Capital and Operating Costs | Bennett |
| 32 | A.C.R.S. Licensing Boards, ECCS | Jordan |
| 33 | Technical Specs (Operating and Environmental) Waste Sources: Gaseous, Liquid, Solid | Brownin |
| 34 | Nuclear Wastes, Disposal | Blomeke |
| 35 | Review | Beall |
| 36 | Quiz | |
| **VI. Transmission (Electrical), Costs, Technology** | | |
| 37 | Overhead (ac-dc), Rights of Way | Long |
| **VII. Consumption** | | |
| 38 | Discussion of Quiz | Beall |
| 39 | Efficiencies of Use, Environmental Effects, Costs Methods of Reducing Consumption of Nonrenewables | Beall |
| 40 | Same as above | Beall |

## HYDROLOGY AND THERMAL-HYDRAULICS

| Session | Subject | Description |
|---|---|---|
| 1 | Introduction | Hydrologic cycle, general circulation, temperature, humidity, wind |
| 2 | Precipitation | Formation, measurement, interpretation of precipitation data, variations, snowfall |
| 3 | Streamflow | Water stage, discharge, interpretation of streamflow data |
| 4 | Evaporation and Transpiration | Factors controlling evaporation, estimates of evaporation, evaporation control, transpiration, evapotranspiration, potential evapotranspiration |
| 5 | Groundwater | Occurrence, soil moisture, aquifers, movement of groundwater, determination of permeability |
| 6 | Groundwater | Sources and discharge of groundwater, hydraulics of wells, groundwater yield |
| 7 | Characteristics of the Hydrograph | Components of runoff, recessions, hydrograph separation |
| 8 | Runoff Relations | Phenomena of runoff, estimating the volume of storm runoff |
| 9 | Runoff Relations | Estimating snowmelt runoff, seasonal and annual-runoff relations |
| 10 | Hydrographs of Runoff | Unit hydrograph |
| 11 | Hydrographs of Runoff | Overland flow, flood formulas |
| 12 | Streamflow Routing | Wave movement, channel storage, reservoir routing, channel routing |
| 13 | Streamflow Routing | Deriving basin outflow by routing, gage relations |
| 14 | Frequency and Duration Studies | Frequency analysis, generalization of frequency data |
| 15 | Frequency and Duration Studies | Generalization of frequency data, related studies |

| Session | Subject | Description |
|---|---|---|
| 16 | Sedimentation | Erosion, suspended sediment, bed load, sediment measurement, resevoir sedimentation |
| 17 | Characteristics of Sediment | Mineralogy, particle size, organics, pH |
| 18 | Ion Exchange Phenomena | Classical exchange equations, selective adsorption phenomena |
| 19 | Factors Affecting Adsorption | Water quality, pH, sediment load |
| 20 | Origin of Waste Heat-Efficiency of Power Production | |
| 21 | Environmental Heat Transfer | |
| 22 | Environmental Heat Transfer | |
| 23 | Temperature Distribution in Natural Water Bodies | Rivers, lakes, reservoirs, estuaries |
| 24 | Near Field Temperature Distribution | Submerged discharge |
| 25 | Near Field Temperature Distribution | Surface discharge |
| 26 | Once Through Systems | Rivers, estuaries |
| 27 | Closed Cycle | Cooling lakes and reservoirs |
| 28 | Closed Cycle | Cooling towers |
| 29 | Physical Modeling | |

## METEOROLOGY

| Session | Subject |
|---|---|
| 1 | Introduction to Atmospheric Diffusion and Diffusion Climatology |
| 2 | Basic Principles of Atmospheric Physics<br>Pressure Gradient Force, Coriolis Force<br>Horizontal and Vertical Structure of the Atmosphere |
| 3 | Lapse Rates; Adiabatic, Dry, Standard |
| 4 | Buoyancy, Wet Adiabatic Lapse Rate<br>General Circulation of the Atmosphere |
| 5 | Problems |
| 6 | Diffusion in the Atmosphere, K-Theory<br>Fick's Law |
| 7 | Planetary Boundary Layer (PBL), Ekman Layer<br>Surface Layer (Adiabatic) ($H<50m$)<br>Logarithmic Wind Profile<br>Ekman Spiral |
| 8 | Logarithmic Wind Profile<br>Stability Length (L)<br>Richardson Number |
| 9 | Wind Distribution in the PBL |
| 10 | Problems (Phys. significance of Richardson No.) |
| 11 | Calculating Dispersion from Point Sources<br>The Simple Gaussian Plume Model |
| 12,13,14 | Evaluating Plume Parameters $\sigma_y$ and $\sigma_z$ |
| 15, 16 | Buoyant Plume Rise (Dry) |
| 17 | Buoyant Plume Rise (Wet) |
| 18,19 | Plume Types (Fumigations; HWF, IBF, LMF, CSF) Plumer Interactions |
| 20 | Building and Stack Aerodynamic Effects |
| 21 | Plume-Terrain Interaction Effects |
| 22 | Area Source Concentration |
| 23 | Concentration as a Function of Averaging Time |

| Session | Subject |
|---|---|
| 24 | Removal Processes (Dry) |
| 25 | Removal Processes (Wet), Precipitation Scavenging |
| | Washout |
| 26 | Rainout |
| 27 | Prediction of Fog and Drift Deposition from Cooling Towers |

APPENDIX V

# REPORT OF A VISIT TO THE BELL LABORATORIES EDUCATION CENTER,

Holmdel, New Jersey, August 1973

In connection with our plans for an ORNL in-house education program, I visited the Bell Laboratories Education Center in Holmdel, New Jersey to learn firsthand details of their training efforts -- in particular, about the outstanding program of in-hours continuing education (INCEP). I left at the end of the day filled with admiration for the corporate philosophy behind INCEP as well as the exemplary way in which the program is carried out. I gained new insights into the distinction between long-term staff development and educational initiatives geared to urgent project requests. At the conclusion of this report, I will list recommendations for an ORNL comprehensive continuing education program.

I was graciously greeted by Carl Wischmeyer, director of the Education Center, who drew the broad picture of the program leaving details of INCEP to Norman Foster, head of in-house activities. Wischmeyer did touch on the extremely interesting area of education for those under the professional level, acknowledging some difficulty in adapting INCEP to fulfill the needs of personnel in this category. The 1973-74 academic year will include a series of application-oriented courses in which one-fourth of the semi-professionals are enrolled. Ironically, a smattering of professionals have also enrolled in these courses.

In his briefing, Norman Foster, a solid state physicist on temporary loan to the Education Center, dealt with two areas -- first, the organization of the program and, second, the time line or calendar of events in a given year's operation. Attachment 1 gives the organizational plan of the program. The Committee on Continuing Education is staffed by people at the executive director's level, which corresponds at ORNL to people just below the Associate Director level. Wischmeyer and Foster are also members. The Vice President Area Committees and the Curriculum Committees feed course ideas into the Central Committees from their two disparate viewpoints: the first is based on the company's organizational structure and the second is derived from technical discipline areas. The pitting against each other of these two opposing viewpoints leads to a quite thorough set of course ideas. There is the further structure of local educational committees made to deal with the far-flung branches of the Bell system.

Foster then turned to the INCEP operational calendar (see attachment 2). The collection of ideas for courses extracted from the negotiations of the Committee on Continuing Education are assembled during the fall of the year; after screening at higher levels, a tentative curriculum is developed. The INCEP staff then distributes this along with a questionnaire to the entire professional staff. They are asked to indicate their interest in the courses or their suggestions of courses not included. Staff response is the most critical element in their final decision to offer a course.

The evaluation of staff responses (about 25%) is followed by the recruiting of instructors and the writing and distribution of the INCEP catalogue. As enrollments are drifting in during the summer months, a variety of educational workshops are organized by the INCEP staff to train instructors and inculcate in them the Bell Labs approach to education.

The term begins in September with pre-class meetings which insure that the instructor and the class are in agreement as to what will be taught in the course. Then after a 3-week delay to allow the enrollment to settle down, lectures begin in earnest. There is extensive use of audio-visual gadgetry; however, Foster stressed that the human instructor is central to all of the teaching strategy. One wise practice is worthy of mention: all lectures are taped so that absent students may keep up.

A questionnaire is distributed after four weeks of class to detect any problems and to gauge the success of new courses. The INCEP staff holds lunches with randomly selected instructors and students midway through each term. A unique form of monitoring takes place through the agency of the course "angel." He is a management level person who often originates the idea of the course and helps recruit the instructor. He sits in on many of the lectures, watching for and quickly solving any problems that arise. If necessary, he will serve as an ombudsman for students who, because of rank-associated timidity, refrain from going directly to the instructor.

How does Bell gauge the cost effectiveness of the program? Foster offered a two-fold response. Since INCEP started in 1969, 700 staff members have been instructors, representing a very valuable resource because of the superb education they received in the process of teaching a course. There is a concerted effort to have turnover in the instructors' ranks. For the 1973-74 academic year, 70 percent of the instructors will be new. Finally, Bell Labs looks at the overall technical output of the staff as the ultimate justification for the program.

In discussing plans for an educational program at ORNL, I indicated that the prinicpal emphasis has been on courses to meet current ORNL programmatic needs. It became clear that INCEP was not designed for dealing with such short-range needs. As just described, an INCEP calendar implies a full year of orchestration for the series of courses. Thus, the main impact of INCEP is for the long-term development of the individual staff members. Indirectly, of course, the company will benefit through the heightened expertise and knowledge of staff members. However, the entire atmosphere of the INCEP Program is voluntary, permissive, and non-competitive.

Urgent short-term needs do generate courses at Bell Labs -- usually one- or two-week sessions. However, these are always handled through the particular Bell System division that has the need. The Education Center is rarely involved and, if so, only through the offering of audio-visual equipment or instructional advice.

Many of Foster's points were amplified in comments I received from John Knudson, a former NYU mathematics professor, who is the Education Center's staff instructor specializing in experimental educational techniques. He has generated a complete course in the complex variable entirely on cassettes plus text material that is largely formulae and derivations. In addition, he tests new courses in the field. For instance, in the 1973-74 academic year, he will teach a course at the Columbus, Ohio branch, commuting once a week from Holmdel.

Knudson pointed out that no grades are given in any of the courses. It is assumed that the students are mature professionals who have voluntarily enrolled in the course and will thus do the work without the artificial incentive of grades. When a student successfully completes a course, the fact is noted in his personnel file; however, a student "failing" a course will have no entry in his record. Thus the students <u>are not compared</u> with one another but are evaluated on their individual merits. Course success has no bearing on salary evaluation.

I asked why college credit was not given for completion of the courses. Both Foster and Knudson answered that the courses were not designed to meet requirements of a college curriculum but to meet the needs of Bell Laboratories. Granting of credit by a university would inevitably result in control of the course and of the school gradually passing to the university.

Another question often raised is why the courses are given in hours rather than after working hours. First of all, costs are less since instructors would have to be paid for after-hours teaching. Secondly, more people find it convenient to take courses during working hours. Most important, the offering of an elaborate curriculum during working hours demonstrates that Bell Laboratories thoroughly believes in the program and is backing it to the hilt.

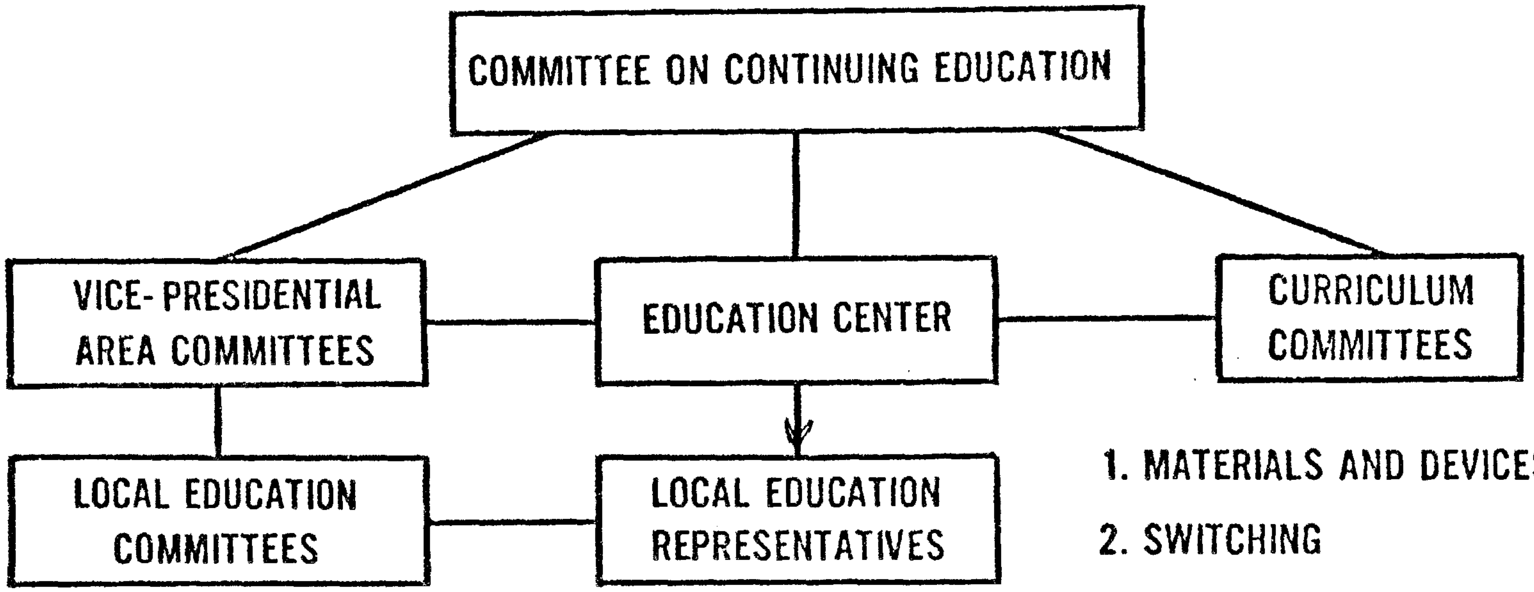
Additional details about INCEP are given in Attachment 3.

## <u>Concluding Remarks</u>

Clearly, ORNL is not Bell Laboratories. However, we can gain valuable insight from examination of their educational programs. I suggest that we develop a two-fold in-house education program, one short term in nature, designed to meet urgent needs and respond to sudden availability of funds. Courses of this nature are already going on -- for example, the plasma physics course in the Thermonuclear Division. Second, we should develop a program closely paralleling the Bell Laboratories' INCEP effort, putting it together slowly and aiming toward September 1974 for the first courses. I believe that the staff response to such a program will be excellent, both in terms of input in the planning stages as well as enrollment in the courses. The positive value of this strong evidence of management's long-term commitment to long-term staff career development would be inestimable.

Attachment 1

# INCEP ADMINISTRATION

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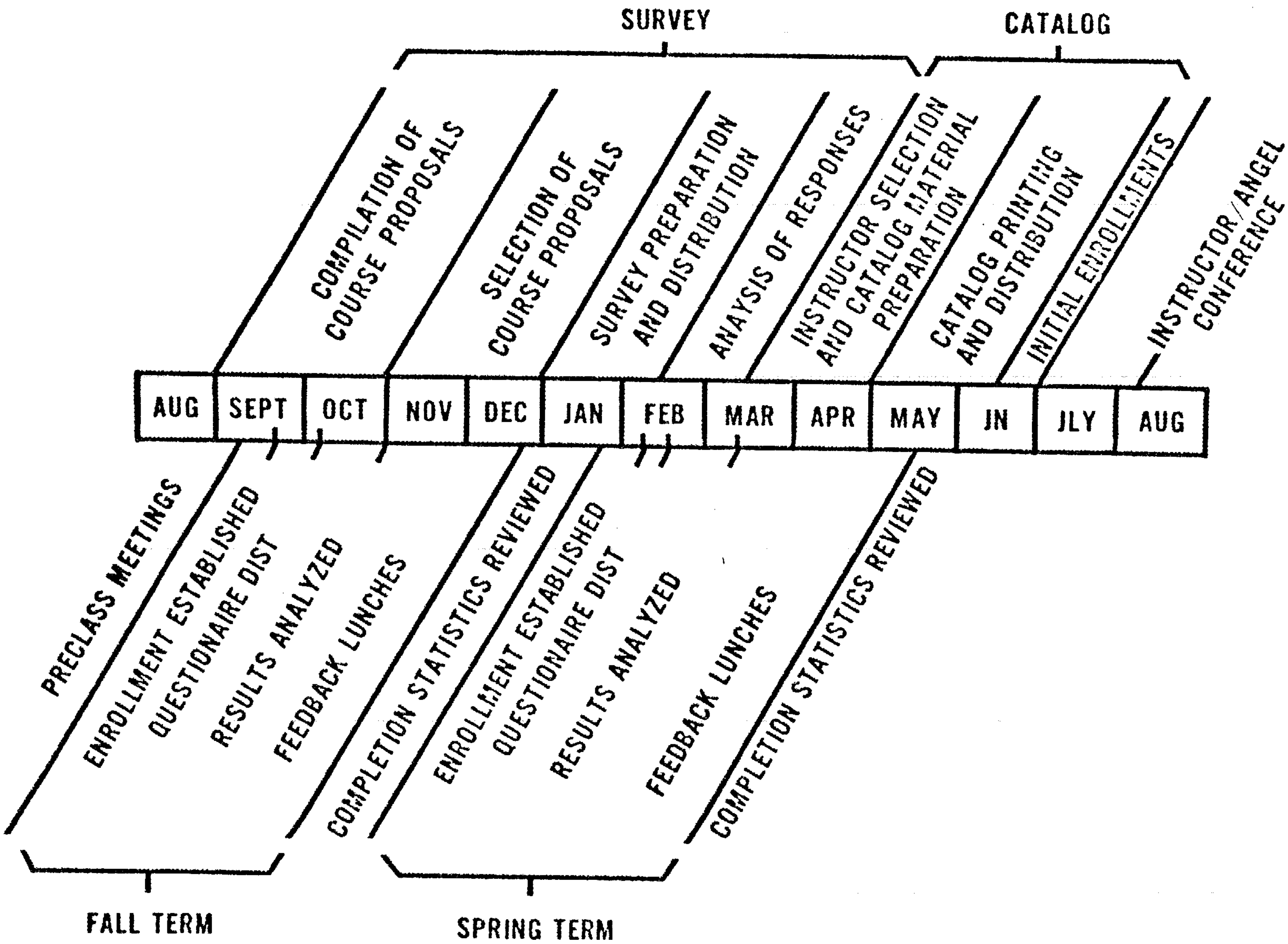
INDIAN HILL, ILL.
MERRIMACK VALLEY, MASS.
RARITAN RIVER, N.J.
READING, PA.

1. MATERIALS AND DEVICES
2. SWITCHING
3. TRANSMISSION
4. BELL SYSTEM ENGINEERING
5. PHYSICAL DESIGN
6. MATH AND COMPUTER SCIENCE

Attachment 2

# INCEP OPERATIONAL CALENDAR



Attachment 3

Fact Sheet on the Bell Laboratories' In-House Continuing Education Program (INCEP)

Established: 1969

Staff Participation: 4000 students in 1973-74, average percentage 35% of professional staff, rather constant over 6 years of operation except in the over 40 category which has shown some decrease this year.

Course Offerings: In 1973-74, 180 different courses with 238 total offerings at the 12 sites.

Instructors: Over 2/3 from Bell staff; allowed half-time for teaching

Students: Any professional staff member, sub-professionals on rare occasions; only record of successful completion; no college credit.

Course Hours: Classes are two hours in length; conducted once a week for about 16 weeks each semester; about 4 hours of homework is necessary in conjunction with each lecture.

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