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ABSTRACT

In order to meet the educational needs for a separate curriculum at the secondary level for technological training related to pollution and corrosion measurement and control, a 3-year, 1080-hour vocational program was developed for use in an area vocational high school. As one of four programs in the technology careers area, this curriculum design has been developed around local needs, as determined by a survey of business and industry. Funded by Pennsylvania's Research Coordinating Unit, the curriculum development project specified a wide range of instructional materials for a tentative course outline, under the title of "Environmental Control Technology." This report consists of a summary of activities undertaken during the development of these materials, intended for use in a 2-hour laboratory or shop program with a 1-hour physics or mathematics academic course. The curriculum outline, together with resource materials, are appended. (Author/AG)

FINAL REPORT

ENGINEERING RELATED TECHNOLOGY

A Laboratory and Curriculum Design for the Newly Emerging Technology of Pollution-Corrosion Measurement and Control

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June 1972

Project Number 19-1021, funded by the Research Coordinating Unit, Bureau of Vocational, Technical and Continuing Education, Pennsylvania Department of Education, Harrisburg, Pennsylvania.

Addendum

The title of the course has been changed to Environmental Control Techrology (Certification number 16.0110)

FINAL REPORT

ENGINEERING RELATED TECHNOLOGY

A Laboratory and Curriculum Design for the Newly Emerging Technology of Pollution-Corrosion Measurement and Control

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June 1972

Project Number 19-1021, funded by the Research Coordinating Unit, Bureau of Vocational, Technical and Continuing Education, Pennsylvania Department of Education, Harrisburg, Pennsylvania.

PREFACE

This report presents a summary of activities undertaken during the development of a pollution and corrosion measurement and control curriculum for secondary level students. The course was developed at the Admiral Peary Area Vocational-Technical School (APAVTS) as one of four programs of study in the technology careers area. Sufficient material has been identified for the average student to cover in approximately 1080 hours over a three year period (grades 10-12). In addition, an effort has been made to arrange the material so that further study through grades 13 and 14 can be pursued with minor modifications to curriculum content.

Admiral Peary is an area vocational-technical school with students attending from 5 sending districts on a "half-day-about" basis, for three hours per day. For the technology careers area, students will attend shop or laboratory for two hours and spend the third hour in either a physics or mathematics academic course.

It is intended that the data herein contained will prove more than adequate to support the contentions that:

I. A need currently exists for high school graduates trained in the technology basic to the field of pollution and corrosion measurement and control,

II. This need will increase in the years to come as government, industry, and the public become increasingly involved in our critical environmental problems, and

III. The proposed curriculum as a course of study unto itself, has not, until now, been available at the secondary level, either in academic or vocational schools.

ACKNOWLEDGEMENTS

The successful completion of this project was due, in large part, to the generous contributions of many advisors, consultants and interested friends in the fields of education, business, science, and engineering. Dr. Bryan V. Fluck, Director of the Admiral Peary Area Vocational Technical School, was a prime mover both in initiating the project and in offering assistance during the actual development of the proposed curriculum.

Funding of the project was made possible through the Research Coordinating Unit of the Bureau of Vocational, Technical and Continuing Education, Pennsylvania Department of Education, under the direction of Dr. Ferman B. Moody and with the assistance of Dr. Carroll Curtis.

Mr. James S. Fluke. P. E., on loan from L. Robert Kimball, Consulting Engineers, Ebensburg, Pennsylvania, deserves the lion's share of the credit for putting together the pieces of a tremendously complex curriculum that covers, among others, the areas of biology, chemistry, physics, earth science, and mathematics. It was a demanding task to coordinate and synthesize the various bits of information from many diverse sources.

Based on his experience in chemical technology in industry, Dr. Edward H. Lareau, Associate Director for Research, Admiral Peary Area Vocational-Technical School and Associate Project Director, was able

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I INTRODUCTION

The population explosion in the United States during the past two decades and the resultant increase in demand for consumer goods and services have been accompanied of late by an increasing public awareness of the detrimental effects certain elements of this growth have had on our environment. Increased demand means increased production; unfortunately, in many instances, increased production results in increased pollution. It is apparent now that the regulatory safeguards that were instituted prior to the '60's along with the state of the art for measurement and control are not sufficient to adequately cope with today's needs in the area of pollution and corrosion measurement and control.

Within the past ten years, federal, state and local governments have conducted extensive studies in an attempt to identify specific problems as they relate to industry, commerce, and the general public. The result has been a concerted effort to find solutions to the most critical of these environmental problems. In many areas, private enterprise is equally involved in this search for practical, acceptable and economical solutions to these problems. Hopefully, from all these activities, methods will be found that not only reduce pollution and corrosion, but also increase productivity and suggest feasible ways to recycle waste materials.

As the investigation continues nationwide and as more extensive and comprehensive techniques are indicated, an increase definitely can be expected in the demand for individuals trained in the basic skills and technology related to pollution and corrosion measurement and control.

For the purposes of this report, definitions of pollution, corrosion, measurement, and control are presented below.

<u>Pollution:</u> The contamination of our environment by any product that renders it physically impure or unclean. Since, in the absence of man, nature itself pollutes, this definition is further limited to concern only contamination due either directly or indirectly to mankind.

<u>Corrosion:</u> A precise definition of corrosion is both difficult to formulate and subject to considerable controversy. In the case of non-metallic materials, corrosion invariably refers to their deterioration from chemical causes, but a similar concept is not necessarily applicable to metals. <u>In the context of this study</u>, corrosion may be defined as "all processes whereby a metal or alloy which is used as a material of construction is transformed from the metallic to the combined state by interaction with its environment."[1] Essentially an electrochemical process, corrosion may take a number of forms, including: pitting, stress corrosion, corrosion fatigue , intergranular corrosion and general wastage (uniform attack).

<u>Measurement:</u> The performance of standard laboratory and field techniques with the appropriate instrumentation and equipment, to include proper sampling techniques and reporting practices.

<u>Control:</u> The comparison of measurement results with accepted standards and the subsequent selection of an appropriate corrective course of action, if any.

A major portion of the course of study to be offered will be directed at pollutants as they affect air, land and water. Air pollutants of primary concern are carbon monoxide, carbon dioxide, nitrogen oxides, sulphur oxides, particulate matter and hydrocarbons. Industrial processes and use of the private automobile are the major sources of air pollution. Land pollutants in the form of solid and liquid wastes will be considered in relation to agriculture, government, mining, industry, commerce and domestic wastes. Specific pollutants of our water resources to be studied will include agricultural wastes in the form of fertilizers, pesticides, herbicides and animal waste; industrial wastes of both liquid and solid nature; municipal wastes, particularly from sewage treatment plants, commercial and domestic pollutants; and mine wastes, particularly acid mine drainage.

A second area to be covered in the curriculum is corrosion. Corrosion can be both a cause of or a result of pollution. Understanding that corrosion is caused by current flow, either from an outside source (stray currents) or due to the potential difference of dissimilar metals in the presence of an electrolyte, has led to the development of new coatings, insulation, cathodic protection, and construction and design techniques that can effectively control the phenomenon. Corrosion is as wide spread and as complex a problem as is pollution.

At present, the training necessary to develop competency in the fields of pollution and corrosion is available at the graduate, undergraduate, and in some cases, two year post-high school (community college) levels. Investigation has revealed little evidence that any formal career training program in this field has been available at the high school level.

It is the purpose of this study to identify specific pollution and corrosion problems as they affect industry, utilities, mining, agriculture, and municipalities, and to develop a comprehensive instructional program in these areas of environmental concern directed at the secondary level student in a vocational-technical school.

The basic instructional program is classified as a technology. Programs of instruction have been developed utilizing units of instruction in other vocational subject areas. Although it is recognized that the purpose of a vocational-technical education is to obtain salable skills for the world of work, other subject areas have been covered in order to enhance the understanding of the student. Since pollution and corrosion are multi-faceted problems encompassing the fields of science, engineering, economics, government, sociology, and education, among others, it seems reasonable to expose the individual student to those areas that will most benefit his education and opportunities in his career choice. Accordingly, the development of this curriculum has been dovetailed with another project on curriculum development[2] at the APAVTS, wherein students are educated according to career choices based on the Dictionary of Occupational Titles.[3] Tasks within units of instruction have been developed at three levels of ability; occupational, skilled and technical. The former two are at levels that can be utilized by students who are disadvantaged or handicapped (but the students will not be restricted to these two levels). Units also have been developed for adult programs directed at fulfilling the needs of the underemployed, the unemployed and the untrained adult, as well as meeting the immediate local needs of several industries and utilities.

The goals of this project are outlined in the initial study proposal as submitted to the Research Coordinating Unit of the Bureau of Vocational, Technical and Continuing Education.[4]

II BACKGROUND

A. The School

The Admiral Peary Area Vocational-Technical School's attendance area serves five of 12 school districts in Cambria County, encompassing a land area of 372.7 square miles, a population of 59,834 persons and real property market valued at approximately $120.8 million. The attendance area comprises about 54 per cent of Cambria County's total land area, almost 32 per cent of its population and approximately 22 per cent of its real property market valuations. Admiral Peary's service area excludes that portion of Cambria County comprising the Greater Johnstown Area situated in the County's southwestern corner, the Townships of White and Reade situated in the northeastern corner of the County and the Townships of Barr and Susquehanna as well as the Boroughs of Barnesboro and Spangler in the northwestern corner of the County. The area served by the Admiral Peary Area Vocational-Technical School, nevertheless, is an integral part of the Johnstown Standard Metropolitan Statistical Area (SMSA) defined by the U. S. Census Bureau as the area coextensive with Cambria County (1970 pop. 186,785) and Somerset County (1970 pop. 76,037) in the southwest-central part of Pennsylvania. Johnstown is the primary industrial and commercial center of Cambria County and many commute to the steel mills of the Bethlehem Steel Corporation and U. S. Steel, the area's major employers. One of the sizable employers in the Admiral Peary attendance area is the Bethlehem Mines Corporation, located at Ebensburg, which functions as a supplier of the bituminous coal used in the manufacture of steel. The Borough of Ebensburg is the county seat of Cambria County and the principal commercial center in Admiral Peary's attendance area. The 15 townships and 16 boroughs included in the vocational-technical school's service area are primarily residential centers, with population clusters of less than 5,000 typically. It is important to note that the area comprising four of the five sending districts in the service area are classified by the federal government as low income areas; they are a part of Appalachia.

B. Legislation

One can easily assess the increasing concern of governmental bodies with pollution control and abatement by reviewing the list of federal and Pennsylvania state laws that are presently in effect. (See Appendix B.) As expected, most of the legislation has been enacted in recent years. Regulatory statutes have expanded to include practically all environmental areas including air and noise pollution. Of perhaps even greater consequence to the graduates of the proposed Engineering Related Technology course at the APAVTS, is the fact that federal, state and local governments have drastically increased their enforcement efforts. Industry is finding it increasingly difficult to delay action on controlling and/or abating pollution. Corrective measures must be taken NOW! Consequently, the need for persons adequately trained in the technology of pollution and corrosion measurement and control is

NOW! The program herein proposed would provide this talent at the time it is most needed.

C. Mining

Foremost among the area industries concerned with pollution and corrosion abatement and control is the bituminous coal mining industry. Within this industry, acid mine drainage is the number one environmental problem. The detrimental biological effects of mine drainage pollution, when added to the loss of recreational values, potable water supplies, corrosion, and other adverse effects must be considered as part of the overall environmental problem in the mining area. Concurrent with the mine drainage problem, serious pollutants exist in the form of mine spoil piles, mine subsidence, raw sewage disposal facilities and unsanitary landfill disposal of solid wastes.

In order to comply with current federal and state mandates, new and improved mining techniques and treatment methods are being investigated to reduce the quantity of mine drainage being discharged into ground and surface waters, and to remove contaminants. Treatment methods currently being evaluated include foam separation of metals, ion exchange treatment, electrochemical oxidation and reverse osmosis. Water recycling is being used successfully in the coal washing process.

It has been demonstrated that a thorough geological and hydrogeological study and evaluation of the area, prior to the beginning of deep or strip mine operation can greatly reduce, and in some cases eliminate the mine water problem. In some cases, potential problem areas can be avoided and frequently groundwater and surface water can be controlled by the construction of various types of containment and diversion structures.

The unsightly and damaging effects of mine spoil piles can be corrected and/or eliminated by collecting extensive soil and geological information relative to the overburden and the surrounding area and adapting the existing chemical, physical and mineralogical techniques to this information in order that the mine spoil can be handled in a safe environmentally acceptable way.[5]

Mine safety standards have been upgraded not only from the standpoint of mine construction and equipment design and operation, but also from the standpoint of more consistent, reliable and comprehensive underground air sampling, monitoring, and testing procedures to guard against underground fires, mine dust, and gas inhalation. The detrimental effects of subsidence, not only to the landscape but to the surrounding underground water supply, can be markedly reduced through the use of fly-ash as fill material. Corrosion of mining tools, equipment, and water distribution lines is also a problem of primary concern.

Numerous deep mines and strip mines, long since abandoned, are polluting streams in the area with acid mine drainage. In an effort to improve the water quality of these streams, environmentalists are evaluating the use of experimental limestone barriers.

D. Utilities

More than forty-eight million dollars has been invested during the last ten years in environmental control facilities at the four area generating stations by the Pennsylvania Electric Company and the station owners. These four generating stations, supplying electricity for twenty million people, are equipped with the latest in pollution control devices. The gases and solid particles produced by the coal burning furnaces are passed through an electrostatic precipitator which removes up to 99.5 percent of these pollutants. Air quality monitoring stations are strategically located in the vicinities of the four generating plants and transmit air-quality data to their respective plants at 15 minute intervals. Although there are no satisfactory methods currently available for the removal of the sulfur content of coal and stack gases, there are more than twenty-five different sulfur oxide removal systems in the experimental stage throughout the country.

Acceptable methods of disposing of the fly-ash collected by the electrostatic precipitators and the commonly referred to bottom ash is another problem common to the electric power industry. Pennsylvania Electric Company and the Bituminous Coal Research Institute are jointly operating an ash utilization research project to explore new ways of turning these ashes into usable wastes. Fly-ash has been used as a sub-base for roads and can be used as an aggregate in manufacturing concrete, bricks, and concrete blocks. It has also been used in fighting mine fires and as a fill in mine subsidence areas. During winter months, bottom ash has been used for road cindering.

In addition to pollution problems, power generating plants are constantly looking for new and improved methods of reducing corrosion. In order to reduce the corrosive effects of untreated water on distribution lines, steel boiler tubes, and expensive related equipment, the water must, in some cases be de-mineralized before use.

Other utilities such as telephone, gas and water, are all faced with many of the same problems, particularly in the areas of corrosion and air and water pollution. Although much progress has been made in the past few years, it is apparent that a great deal of research and development effort will be required for years to come.

E. Steel

Few people not directly associated with the steel industry are aware of the enormous volumes of water and air required to produce iron and steel from raw materials to finished products. For example, to produce one ton of finished iron in a blast furnace, approximately

3.5 tons of air and 150 tons of water are required.

A by-product of this process is the production of numerous troublesome pollutants in our air and water resources. Typical air contaminants resulting from this operation are:[6]

1. Particulates
2. Sulfur compounds
3. Carbon Monoxide
4. Cyanides
5. Fluorides
6. Benzene compounds

Potential water pollutants present as by-products in the steel industry are:[6]

1. Oils
   a. Rolling oils
   b. Lubricants
   c. Hydraulic oils
   d. Quench oils
   e. Fuel oils
   f. Solvents
   g. Tars and Pitch
2. Suspended Solids
   a. Scale
   b. Sand
   c. Burden Fines
   d. Fly Ash
   e. Coal and Coke
3. Chemicals
   a. Pickle liquor
   b. Acid sludge
   c. Caustic wash
   d. Lime
   e. Brine

The largest use of air is in the conversion of iron ore to pig iron, with additional large volumes being required by all the related fuel burning operations. Gases other than air, particularly pure oxygen, are used in steel making and become a part of the gas discharge from manufacturing operations.

The large water demands of the industry stems from its use as a coolant for the blast furnaces, gas wash water (including that used in the electrostatic precipitators) from air scrubbers, and cooling water used to cool the blast air valve leaving the stove.

Among the steps being taken by the steel industry to reduce or eliminate environmental contamination resulting from the production of these potential pollutants is the installation of electrostatic precipitators to remove the various particulate matter produced; the use of scrubbers to remove a high percentage of noxious gases; installation of closed water systems to permit collection and re-use of large amounts of water; clarification of gas wash water to remove the dust carried over from the blast furnace; and disposal of the remaining solid wastes such as mill refuse, slag, and domestic waste by incineration and/or sanitary landfill.

The use of such large quantities of water, requiring miles of in-plant distribution lines in addition to storage and treatment facilities, introduces corrosion to the list of problems inherent in the steel industry. Corrosion, unabated, can quickly hamper the performance of sensitive, costly equipment. Not only is repair and replacement of such equipment expensive, the "down time" resulting from such activities can seriously affect production costs.

F. Agriculture

Although less publicized in terms of its contribution to environmental pollution, the agricultural field must be considered. Inasmuch as Cambria County is one of the largest potato producing regions of the state, some graduates of the Engineering Related Technology curriculum to be offered at the APAVTS will be concerned with the ecological effects of fertilizers, pesticides, and herbicides.

The persistent application of nitrate and phosphate fertilizers to farmland generates in the soil the need for more of the same. Although they must be considered a technological success because they do succeed in raising the amounts of free nutrients in the soil, it is precisely this success that leads to eutrophication as these nutrients are leached out of the soil by ground and surface water.

The effects of insecticides on soils are not readily understood due to our ignorance of the interactions of these substances with soil microorganisms. Recognizing that most of the complex physical and chemical processes responsible for soil fertility are dependent on soil organisms, environmental biologists are appalled by continuing use of heavy dosages of deadly insecticides such as DDT which destroys non-target insects along with the target pests. It has also been demonstrated that relatively small concentrations of DDT in water reduces photosynthesis by marine phytoplankton.

Herbicides are being used at an increasing rate to keep roadsides, right of ways and sewerlines free of shrubs and weeds. Although their direct toxicity to animals is low, herbicides do have a considerable impact on animal populations that depend directly or indirectly on plants for food.

The serious effects of this agricultural pollution on our ground and surface water supply is exemplified in part by the much publicized and well documented fate of Lake Erie. Besides fertilizing their farms with nitrogen and phosphorus, the farmers are also fertilizing Lake Erie.[7] The nitrogen contribution of the estimated 30,000 square miles of farmland situated in the Lake Erie basin is of the same order of magnitude as that of municipal and industrial polluters. The resultant abundance of inorganic nitrates in the lake disturbs the nitrogen balance and encourages the growth of certain algae. These huge masses of algae grow very quickly, cover huge areas, foul beaches, and then die. Their bacterial decay process consumes considerable oxygen, thus reducing the amount available for fishes and other animals. Much of the nitrate and phosphate remains in the lake, settling to the bottom with the decaying mass of algae.

It has been predicted that in twenty-five to thirty years, the ultimate crisis in agriculture will occur in the United States. Either the fertility of the soil will drop precipitously, throwing the nation into a food crisis, or the amounts of inorganic nitrates and phosphates applied to the land will be so large that they could pose an insolvable water pollution problem.

Controlling or eliminating agricultural pollution is not limited to fertilizers, pesticides and herbicides; animal waste must also be considered. Although treatment of animal waste is now required by existing statutes, this does not really solve the problem. New concepts are being developed and investigated, but careful monitoring of these "solutions" will be necessary to assess the long and short term effects on our environment.

G. Sanitary Wastes

Typical of similar communities, the area surrounding the APAVTS is in the process of developing additional water supply and distribution systems, domestic sewage collection and treatment facilities and improved, acceptable solid waste collection, transportation and disposal methods.

As stream classifications within the Commonwealth are revised, many of the existing waste water treatment plants must be upgraded from primary to secondary or secondary to tertiary to include phosphate removal. As the treatment plant becomes more sophisticated, the plant operator must become more knowledgeable.

Federal and state regulations have forced municipalities to investigate alternatives to the local "dump" as a means of disposing of solid wastes. Sanitary landfills, with or without pretreatment such as shredding, composting, incineration, or pyrolysis must be considered depending on the area needs. Technology has introduced practical, relatively effective methods of separating materials that can be reused and recycled.

III PROCEDURE

A. Need for Course

The first consideration in the development of the proposed Engineering Related Technology curriculum was to conduct a thorough search of the literature in order to accurately determine the need for such a course and to confirm the conviction that there does exist a need for this course at the secondary level. As expected, a wealth of material has been published within the past few years calling attention to past, present and future problems in the pollution - corrosion fields. Environmentalists have identified specific problems as they relate to various industries and have assessed their effect on the total environment. The literature search also verified the suspicion that training in the technology related courses has been limited to post secondary students. It has not been available to secondary level students as a course unto itself. With the present emphasis on developing new and better methods of controlling and abating pollution and corrosion, there is every reason to expect that if technically qualified high school graduates are available, job opportunities will definitely exist.

B. Preliminary Investigation

To better develop the proposed curriculum to fulfill existing needs of local employers in industry, business, utilities, and government, interviews were held with knowledgeable persons in the various fields.

Based on these interviews, the specific problems were identified and classified in relation to particular curriculum content.

Numerous businesses, industries, organizations and government agencies were contacted during the fall of 1971 and the early part of 1972. Information concerning the pollution and corrosion problems faced by these firms and the corrective measures being taken were obtained. Inquiries into their technology needs were also made, specifically as they related to their measuring and control procedures. Considerable insight was also gained as to the future needs of the particular organizations in the technology field. A list of organizations contacted is presented in Appendix C.

After assembling and analyzing the available information, inquiries were made into the educational field. Informants were briefed on the purpose of this study and were requested to share their personal experiences in this realm of activities with the investigators. Institutions contacted included universities, colleges, community colleges and secondary schools. Personal acquaintances in the teaching profession were also invited to contribute their ideas and offer critical comment. The material gathered during this phase of the study, when combined with that obtained from earlier investigations, provided the information necessary to establish a broad, preliminary curriculum guide. A list of the educational institutions contacted is presented in Appendix C.

Concurrent with the personal interviews, written inquiries, and telephone contacts being conducted with the above mentioned organizations and institutions, regularly scheduled meetings were held with the Technical Advisory Committee for the Engineering Related Technology course. In addition meetings were held with the mathematics teachers and the science teachers from the six sending high schools to be sure that prerequisite materials were available in the home school. A list of committee members and copies of minutes of the above mentioned meetings are included in Appendix D. A progress report was submitted to the Research Coordinating Unit for their consideration and a reassessment of activities to date was conducted by the technical advisory committee members and project personnel. The proposed course of action for the subsequent period was introduced, modified if indicated, and agreed upon. A chronological list of activities appears in Appendix E.

C Curriculum

At the conclusion of the information gathering phase of the study, primary efforts were directed at establishing a curriculum outline based on a critical analysis of all material thus far collected. As the study progressed and refinements were made to the curriculum, a meaningful relationship was developed between the academic and technical training necessary to accomplish the ultimate goal of providing the high school graduate, the handicapped and the unemployed, underemployed, or untrained adult, a course of study that would adequately prepare them to compete in today's technically oriented job market.

Based on the information gathered up to this point, (see appendix F for a complete list of all publications reviewed during this project) it was determined that the course should encompass the following subject material:

1. Identifying areas of corrosion and pollution as they affect industry, utilities, mining, agriculture and natural resources,

2. Analyzing air, water, and soil to determine existence and extent of pollution,

3. Studying of pollution and corrosion control in use in various industries,

4. Describing the effect of foreign matter on natural resources, water supplies and watersheds,

5. Discussing existing legislation on environmental control,

6. Listing methods of disposal of wastes such as gases, oils, water and other chemicals,

7. Studying metals and alloys to determine how they are affected by water and other substances,

8. Performing laboratory procedures and skills used in testing chemical, physical and biological parameters in liquid and solid wastes, foods, water and air, and

9. Comparing methods of sampling, weighing, and measuring with regard to precision, accuracy and utility available with each.

The Engineering Related Technology curriculum, like the other nineteen (19) courses offered at the APAVTS, will become part of a larger career preparation project that utilizes a flexible scheduling arrangement to achieve an unlimited number of career offerings. Referred to as TIME

Scheduling (Temporally Individualized Modular Education), the project goal is to design a general model applicable to all ability levels and all curriculum areas of education. (See Appendix G.)

The scheduling arrangement will utilize the educational module descriptions developed in two projects[2, 8] carried on concurrently with the one reported herein.[4] These modules, when put together, will allow the student and counselor to tailor an occupational program to the abilities and aspirations of each individual student. The student is allowed to proceed through the modules, as they are scheduled, at his own rate. Thus, a student completing a module early may proceed to another module as soon as possible. Conversely, a student requiring more than the allotted time for a module will be rescheduled to finish that module as soon as possible.

After the relationships were determined between the proposed instructional modules and other programs in vocational technical education, specifications were prepared for all task instructional sheets. A complete curriculum outline at the task level, including suggested prerequisites and approximate time for the average student to complete a specific module, is presented in Appendix H. Careful consideration was exercised to insure that the curriculum format was compatible with the TIME Scheduling Project requirements.

One final activity was undertaken to make the results of this project compatible with the goals of the two modular scheduling projects. The study programs are designed to provide graduates with the basic technical skills and knowledge necessary to qualify for employment[9] in one or more of the job opportunities listed in the Dictionary of Occupational Titles.[3] See Appendix I for a partial listing of occupational opportunities open to graduates of this course.

D. Equipment and Supplies

Upon completion of the module and task designations for instruction, an investigation was begun to determine the equipment and supplies necessary to fulfill the goals of each module or task. The investigation consisted of:

1. Classification of the curriculum content by equipment required,

2. A compilation and evaluation of equipment and supplies used by other teaching institutions where like courses are offered,

3. A thorough analysis of materials and equipment being used in commercial and industrial laboratories where the students will ultimately be employed, and

4. A review of laboratory equipment and supplies publications.

A list of the equipment, instruments, furniture, and supplies that will be available initially appears in Appendix J. A floor plan of the instructional area and the laboratory is presented in Appendix K.

IV SUMMARY

A new curriculum has been developed for the emerging field of pollution and corrosion measurement and control. The general thrust of the curriculum has been developed around local needs, as determined by a survey of local businesses, utilities, industries, local governments and educational institutions. Individuals representing several educational institutions along the eastern seaboard were most helpful in determining specific curriculum content.

The curriculum development projected, funded by the Research Coordinating Unit, was conducted in conjunction with two other projects on flexible modular scheduling for career education.

A major element of the modular scheduling projects deals with educating students for specific occupations, as designated in the Dictionary of Occupational Titles, rather than in the traditional subject matter programs. Curriculum materials are specified for jobs in the fields of mining, agriculture, utilities, steel, and municipal waste treatment. Thus, more material is specified than any one student could possibly cover in a three year program. Additionally, it should be kept in mind that a major function of vocational-technical education is to have the student obtain a salable skill for gainful employment. Further education beyond high school is particularly important in the technologies area. Thus, despite the vast amount of designated curriculum content, it is not expected that the average secondary level student will be able to master all the theory involved by the time he or she graduates high school. It should also be understood that the detailed course outline presented here is only a first approximation and that changes, additions and deletions will be made as experience is gained in the classroom.

One final comment not heretofore mentioned concerning the course title. When the curriculum development project was initiated, a suggested course title was "Environmental Engineering." However, that title was already being used for courses in heating and air conditioning. The current title, Engineering Related Technology might be too easily confused with an existing course, Engineering Technology. It is recommended that the course title be changed to Environmental Control Technology (16.0110).

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Appendix A

A Listing of Individuals

Contributing To The Project Activities

Cunningham, Mr. James, Peoples Natural Gas Co., Johnstown, Pa.

Davis, Mr. John, Pennsylvania State University, University Park, Pa.

Dwiggins, Mr. Gordon, Fayetteville Technical Institute, Fayetteville, N. C.

Einodshofer, Mr. Robert, Pennsylvania Electric Co., Altoona, Pa.

Fyock, Mr. David, Pennsylvania Electric Co., Johnstown, Pa.

Gaudlip, Mr. John, L. Robert Kimball, Consulting Engineers, Ebensburg, Pa.

Kimlin, Dr. Jayne, St. Francis College, Loretto, Pa.

Kohlbeck, Mr. Roland A., L. Robert Kimball, Consulting Engineers, Ebensburg, Pa.

Lambert, Mr. Donald, Peoples Natural Gas Co., Johnstown, Pa.

Lommock, Mr. Richard, Greater Johnstown Area Vocational-Technical School, Johnstown, Pa.

Long, Mr. David, Pennsylvania State University, University Park, Pa.

McCombs, Mr. C. G., Bell Telephone Co., Indiana, Pa.

Newton, Mr. David, Broome Technical Community College, Binghampton, N. Y.

Paxton, Mr. John, Greenville Technical Education Center, Greenville, S. C.

Petrosky, Mr. John, Bishop Carroll High School, Ebensburg, Pa.

Price, Mr. Carrol, Pennsylvania State University, University Park, Pa.

Schwing, Mr. Carl, Charles County Community College, La Plata, Md.

Shingler, Dr. Roger, L. Robert Kimball, Consulting Engineers, Ebensburg, Pa.

Steinback, Mr. Tim J., Shelocta, Pa.*

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* Mr. Steinback layed some of the ground work during the first two months of this project; however, he was unable to continue as a full time employee on the project.

Appendix B

Partial Listing of Federal and Pennsylvania

Laws Concerning the Environment

Federal Laws

National Environmental Policy Act of 1969

Environmental Quality Improvement Act of 1970

Environmental Education Act of 1970

Air Quality Act of 1967

Health Manpower Training Act of 1971

Solid Waste Disposal Act of 1965

Resource Recovery Act of 1970

National Materials Policy Act of 1970

Federal Water Pollution Control Act

Water Quality Improvement Act of 1970

Rivers & Harbors Act of 1899 (Refuse Act)

Water Resources Research Act of 1964

Water Resources Planning Act of 1964

Fish & Wildlife Coordination Act

Federal Insecticide, Fungicide & Rodenticide Act

Pennsylvania State Laws

Pa. Clean Streams Law (Act of 1937; amended 1945, 1965, & 1970)

Pa. Solid Waste Management Act of 1968

Pa. Bituminous Coal Open Pit Mining & Conservation Act of 1945 (amended 1963 & 1968)

Pa. Anthracite Strip Mining & Conservation Act

Pa. Air Pollution Control Act

Appendix C

A List of

Organizations Contacted

A. <u>Organizations Other Than Educational Institutions</u>

American Chemical Society
Washington, D. C.

American Public Health Association
Washington, D. C.

American Waterworks Association
New York, N. Y.

Army Corps of Engineers
Pittsburgh District
Pittsburgh, Pa.

Barnes and Tucker Coal Company
Barnesboro, Pa.

Bell Telephone Company
Indiana, Pa.

Bethlehem Mines
Ebensburg, Pa.

Bethlehem Steel Corporation
Johnstown Plant, Johnstown, Pa.

Environmental Education Center
Washington, D. C.

Environmental Protection Agency
Washington, D. C.

Environmental Sciences, Inc.
Pittsburgh, Pa.

Federal Water Quality Administration
Charlottesville, Virginia

National Association of Corrosion Engineers
Houston, Texas

National Sanitation Foundation
Ann Arbor, Michigan

New York State Dept. of Health
Albany, New York

Pennsylvania Department of Environmental Resources
Harrisburg, Pa.

Pennsylvania Electric Company
Johnstown, Pa.

Peoples Natural Gas Company
Johnstown, Pa.

U. S. Steel Corporation
Pittsburgh, Pa.

Water Pollution Control Federation
Washington, D. C.

B. Educational Institutions

Broome Community College, Binghampton, N. Y.

Centre County Vo-Tech School, Pleasant Gap, Pa.

Charles County Community College, La Plata, Md.

Community and Technical College, Univ. of Toledo, Toledo, Ohio

Fayetteville Technical Institute, Fayetteville, N. C.

Greenville Technical Education Center, Greenville, S. C.

Indiana Vocational-Technical College, Lafayette, Indiana

Industrial Technical Institute, Pittsburgh, Pa.

Johnstown Area Vo-Tech School, Johnstown, Pa.

Muskingum Area Technical Institute, Zanesville, Ohio

Olive-Harvey College, Chicago, Illinois

The Pennsylvania State University, University Park, Pa.
- Center for Air Environment Studies
- Chemical Engineering Department
- Education Department
- Institute for Research on Land and Water Resources

Penta Technical College, Perrysburg, Ohio

Santa Fe Jr. College, Gainesville, Florida

School of Technology, Purdue University, Lafayette, Indiana

St. Francis College, Loretto, Pa.

University of Pittsburgh at Johnstown, Pa.

All Vocational-Technical Secondary Schools within the State of Pennsylvania.

Appendix D

Technical Advisory Committee Members

and Minutes of Meetings Related to the

Engineering Related Technology

Course

ADMIRAL PEARY AREA VOCATIONAL-TECHNICAL SCHOOL

TECHNICAL ADVISORY COMMITTEE

COMMITTEE MEMBERS FOR
ENGINEERING RELATED TECHNOLOGY

Fedorka, Mr. Walter, P. E., Chairman
(Engineer), Walter L. Fedorka, Consulting Engineers, Portage, Pa.

Kimlin, Dr. Jayne
Chemist, St. Francis College, Loretto, Pa.

Mihalko, Mr. David
Walter L. Fedorka, Consulting Engineers, Portage, Pa.

Shingler, Dr. Roger
Chemist, L. Robert Kimball, Consulting Engineers, Ebensburg, Pa.

Todhunter, Mr. John S.
Barnes and Tucker Coal Company, Barnesboro, Pa.

SUPERINTENDENT
F. K. SHIELDS

Admiral Peary Vocational Technical School
P. O. BOX 96
EBENSBURG, PENNSYLVANIA 15931
PHONE 472-8490 OR 472-8491

DIRECTOR
BRYAN V. FLUCK

Operating Committee Meets:
1st Thursday of the Month
at 7:30 p.m.

MINUTES of THE
ENGINEERING RELATED TECHNOLOGY
TECHNICAL ADVISORY COMMITTEE MEETING
10 March 1972

The meeting was called to order at 7:00 P.M., Thursday, 9 March, 1972, in the Research Offices of the Admiral Peary Vocational Technical School in Aquinas Hall of Bishop Carroll High School; Ebensburg, Pennsylvania.

Those in attendance were:

Mr. Larry Covell
Mr. Walter Fedorka
Mr. James Fluke
Mr. Charles Green
Dr. Edward Lareau
Mr. David Mihalko
Mr. John Petrosky
Mr. Charles Wilson

Mr. Covell explained the duties of a placement officer and asked the committee about job opportunities in the general Ebensburg area. Committee members felt that the students' best chances for employment would be in mining, the utilities or governmental agencies. Based on laws concerning pollution, it would appear that proper sampling and laboratory techniques for air, water and solid pollution are vital to pollution control. Companies engaged in coal research, such as the Rochester and Pittsburgh Coal Company, would be potential employers of graduates of the program. The committee agreed that the placement officer should visit prospective employers to discuss summer work and cooperative work experience for the students.

Dr. Lareau explained the TIME Scheduling project and asked for comments on the proposed curriculum. The committee agreed that the proposed curriculum pretty well covered the content of a secondary level course in pollution and corrosion technology. However, they offered the following suggestions as additions to the curriculum:

- Modules on thermal pollution should be added,
- Modules on automobile pollution, particularly the nitrogen oxides and carbon monoxide, should be included,
- Modules on recycling and recycling centers should be added,
- A Unit on soils, to include geology and soil packing should be included, and
- Modules on pollution by mercury, cadmium, lead and arsenic should be added.

Mr. Green discussed requirements for instructional equipment. Committee members reviewed drawings of the Engineering Related Technology laboratory and instructional area and made the following comments:

- Students should share equipment drawers to be located under most benches (2 students per drawer);

- A lockable storage area for storage of chemicals and certain equipment should be provided,
- Bench service should include hot and cold water, gas, and electricity,
- Mo-e fume hoods should be provided, and
- The room should be layed out according to areas (e.g. chemical, physical, biological, and general activities).

A special meeting was set for 15 March, 1972, to discuss the laboratory layout.

The meeting was adjourned at 9:30 P.M.

Respectfully submitted,

Edward H. Lareau
Associate Director for Research

Admiral Peary Vocational Technical School

SUPERINTENDENT
F. K. SHIELDS

P. O. BOX 98
EBENSBURG, PENNSYLVANIA 15931
PHONE 472-6490 OR 472-6491

DIRECTOR
BRYAN V. FLUCI

Operating Committee Meets: 1st Thursday of the Month at 7:30 p.m.

MINUTES of THE
ENGINEERING RELATED TECHNOLOGY
TECHNICAL ADVISORY COMMITTEE SPECIAL MEETING
17 March 1972

The meeting was called to order at 2:00 P.M., Wednesday, 15 March, 1972, in the Research Offices of the Admiral Peary Vocational Technical School in Aquinas Hall of Bishop Carroll High School, Ebensburg, Pennsylvania.

Those in attendance were:

Dr. Roger Shingler - L. Robert Kimball, Consulting Engineers
Dr. Jayne Kimlin - St. Francis College
Mr. John Todhunter - Barnes & Tucker Coal Company
Mr. John Petroskey - Bishop Carroll High School
Dr. Edward Lareau - Admiral Peary Area Vocational Technical School
Mr. James Fluke - Admiral Peary Area Vocational Technical School

The special meeting was called for the purpose of reviewing laboratory layout, furniture, instrumentation and equipment.

A thorough discussion ensued and it was unanimously recommended that the laboratory be revised to conform closely to chemistry and biology technology laboratories with a separate area designated for water hydraulics. Another area was designated for large permanent type instrumentation, in addition to an area designated specifically for weighing balances.

A general review was made of all instrumentation at this time to take advantage of the expertise represented by this committee.

The meeting adjourned at 5:00 P.M.

Respectfully submitted,

JSFluke

James S. Fluke
Professional Engineer

Admiral Peary Vocational Technical School

SUPERINTENDENT
F. K. SHIELDS

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DIRECTOR
BRYAN V. FLUCK

Operating Committee Meets:
1st Thursday of the Month
at 7:30 p.m.

MINUTES of SPECIAL MEETING
with Sending School Science Teachers
To Discuss The Engineering Related Technology Curriculum
29 March 1972

The meeting was called to order at 7:30 P.M., Monday, 27 March, 1972, in the Research Offices of the Admiral Peary Vocational Technical School in Aquinas Hall of Bishop Carroll High School, Ebensburg, Pennsylvania.

Those in attendance were:

Name	School
Mr. Cameron Benko	Portage Area High School
Mr. Larry G. Covell	Admiral Peary Vo-Tech
Mr. Joseph N. DeSalvo	Blacklick Valley High School
Mr. Jules Dill	Central Cambria High School
Mr. James S. Fluke	Admiral Peary Vo-Tech
Dr. Edward H. Lareau	Admiral Peary Vo-Tech
Mr. John Petroski	Bishop Carroll High School
Mr. John Solarczyk	Penn Cambria High School
Mr. Charles Wilson	Admiral Peary Vo-Tech

Dr. Lareau explained that the students in the four technology programs at the Admiral Peary Area Vocational Technical School would spend 1 of their 3 hours each day at the vo-tech school in either a mathematics or physics course during each of the 3 years. The two mathematic courses will be the standard academic geometry and trigonometry taught at the home schools. The physics course will be the standard physics course taught at the sending schools.

Mr. Covell discussed a diagram comparing course offerings in the mathematics and science departments of each of the sending schools.

Mr. Wilson explained the need for flexibility on an individual basis with students because students enrolled in the technologies had various backgrounds from business to science majors.

Mr. Fluke distributed copies of a draft of the curriculum for Engineering Related Technology as it had been developed to that point. The curriculum was discussed module by module for science prerequisites. Mr. Fluke stated that the suggested prerequisites would be accounted for in the final curriculum outline.

The meeting adjourned at 9:45 P.M.

Respectfully submitted,

E. H. Lareau

Appendix E

Chronological List of Events

15 Oct. - 3 Dec., 1971	T. J. Steinback makes initial contacts for information gathering activities.
15 Dec., 1971	J. S. Fluke and C. R. Theisen toured the Centre Co. Vocational-Technical School (selected because it has a similar 1/2 day program and physical plant to the Admiral Peary Area Vocational-Technical School).
16 - 18 Dec., 1971	Curriculum Conference # 1 in Ebensburg in conjunction with consultant from The Pennsylvania State University - wrote outline to careers in Units, Modules, and Tasks.
6 Jan., 1972	Contacted Mr. Robert Einodshofer of Pennsylvania Electric Co. concerning corrosion and a visit to plant facilities. Contacted Mr. Donald Lambert of Peoples Natural Gas Co. concerning corrosion problems of underground pipe line. Contacted Mr. C. G. McCombs, Industrial Relations Department Representative of Bell Telephone Co. concerning corrosion problems with telephone lines and cable.
16 Jan., 1972	Mr. McCombs visited our office, reviewed

corrosion problems, arranged contact with Bell Telephone Laboratories.

25 Jan., 1972	J. S. Fluke attended System/7 classes at I.B.M., Pittsburgh, Pa.
26 Jan., 1972	J. S. Fluke visited Greenville Technical Education Center at Greenville, S. C. Mr. John Paxton, Head, Environmental-Chemical Technology Department, was the host for the all day visitation. The environmental course is basically a water and waste water treatment course with strong background in chemistry. There are 30 students enrolled in this 2 year post high school course. Total enrollment at Greenville Technical Education Center is 12,000. A course outline, a list of laboratory equipment, and curriculum catalog were obtained.
27 Jan., 1972	J. S. Fluke visited Fayetteville Technical Institute, (F.T.I.) Fayetteville, N. C. Mr. Gordon Dwiggins, Chairman, Environmental-Engineering Technology Dept., was the host. Fayetteville Tech. Institute is a 2 year post high school Community

College type school. Environmental Engineering Technology is basically a water and air pollution measurement and control course and was first offered at F.T.I. in 1964. Mr. Dwiggins was most generous with his experiences and knowledge and provided a large volume of usable information and assistance in organizing this course. A comprehensive report of course outline, and laboratory equipment was sent to APAVTS. Total enrollment at Fayetteville is 1000 - with 27 students currently enrolled in Environmental Engineering Course.

28 Jan., 1972

J. S. Fluke visited Charles County Community College, (C.C.C.C.), La Plata, Md. Mr. Carl M. Schwing, Chairman, Department of Pollution Abatement Technology, was the host. Mr. Schwing, a man of wide and varied experience in the pollution field, was most generous with his assistance and advice in establishing this course. The Pollution Abatement Technology (P.A.T.)

course is a 2 year course for Post high school students. This Course has been offered since 1966 but has undergone extensive revision until it is now basically a waste water treatment plant operators training course. Plant operators are trained to be capable of passing state requirements for a treatment plant operator upon graduation.

Of the approximately 1200 students enrolled at C. C. C. C., 47 were taking the two year course in P. A. T. A current college catalog and other course and reference material were furnished to us.

1 Feb., 1972

Robert Einodshofer of Pennsylvania Electric Company took J. S. Fluke to tour facilities at Homer City Generating Station and to observe pollution control devices and laboratory operations. Dave Fyock, Director of Research for Pennsylvania Electric Company was host for the visit. The Homer City plant is concerned with the environmental problems primarily dealing with corrosion, air pollution, water pollution,

	and thermal pollution.
3 Feb., 1972	Progress Report sent to Research Coordinating Unit, Harrisburg, Pa., concerning status of course development.
15 - 16 Feb., 1972	Dr. Victor Dupuis and Dr. Paul Bell from Pennsylvania State University here on common module layout.
28 Feb. - 3 Mar., 1972	J. S. Fluke attended I. B. M. seminar on System/7 remote sensor applications at Poughkeepsie, N. Y.
9 Mar., 1972	Technical Advisory Committee meeting to discuss curriculum content, jobs available for graduates, and equipment list for laboratory.
10 Mar., 1972	Visit with Dr. Kimlin at St. Francis College concerning laboratory layout, equipment and instrumentation list.
11 Mar., 1972	Meeting with Mr. Richard Lommock, metallurgy instructor at the Johnstown Vocational-Technical School and Mr. John Petrosky, chemistry instructor at Bishop Carroll High School concerning course content and laboratory instrumentation and equipment list.

14 Mar., 1972	J. S. Fluke visited Broome Technical Community College, Binghampton, N.Y. Mr. David F. Newton, Asst. Prof. in Environmental Health Technology Dept., was the host. Mr. Newton was most cooperative with information, advice and assistance concerning the establishment of this course. The vironmental Health Technology course is a 2 year, post high school course, primarily dealing with the control of those factors in the physical environment which may exert a harmful effect on man's health. Graduates enter careers as government food, health, and environmental inspectors. Admiral Peary Area Vo-Tech School was furnished with a copy of the course catalog and outline, a laboratory equipment list, and a text and publication list.
15 Mar., 1972	Met with Technical Advisory Committee members to review course content, equipment, furniture and laboratory layout.
23 Mar., 1972	Specifications for laboratory furniture were prepared.

27 Mar., 1972	Meeting with science teacher representatives from each of the six sending high schools to discuss science prerequisites for the Engineering Related Technology course.
4 April, 1972	Meeting with Mr. Paul Porada of Kimball Engineers concerning assistance in developing the water treatment area of course.
4 April, 1972	Meeting with mathematics teacher representatives from each of the six sending high schools concerning mathematics prerequisites for the Engineering Related Technology course.
13 April, 1972	Meeting with Mr. Roland Kohlbeck and Dr. Roger Shingler of Kimball Engineering concerning assistance in writing sanitary and chemistry curriculum content, respectively.
21 April, 1972	Meeting with Mr. John Gaudlip of Kimball Engineering concerning assistance in writing fluid mechanics curriculum area.
28 April, 1972	First draft of curriculum at the task level.
28 - 29 April, 1972	Curriculum Conference # 2, attended by Technical Advisory Committee members, for all 20 program areas for the APAVTS.

2 May, 1972	Selection of laboratory instruments, equipment, and furniture.
12 May, 1972	Mr. Charles Walters of Kimball Engineering began first draft of project report for the Engineering Related Technology course.
15 - 18 May, 1972	J. S. Fluke attended underground corrosion conference at W. Va. University.
26 May, 1972	First draft outline prepared for entire project report.
23 June, 1972	Final draft of project report for review and editing.

Appendix F

List of Suggested Reference Materials

Journals

Chemical and Engineering News, (Washington, D.C.: American Chemical Society)

Chemical Technology, (Washington, D.C.: American Chemical Society, Publications Division)

Environmental Science & Technology, (Washington, D.C.: American Chemical Society)

Journal of Chemical Education, (Easton, Pa.: Division of Chemical Education of the American Chemical Society)

Research/Development, (Barrington, Illinois: Technical Publishing Company)

Scientific American, (New York, N.Y.: Scientific American, Inc.)

Business Publications

IBM, IBM System/7 Functional Characteristics, Second Edition. (Copyright International Business Machines Corporation, 1971)

IBM, IBM System/7 System Summary, Second Edition, Copyright International Business Machines Corporation 1970, 1971

IBM, Technical Newsletter, System/7, Base Publ. No. GA34-0003-1, Newsletter No. GN34-0028, (Boca Raton, Florida: IBM Corporation, Systems Publications, 1971)

Information Services

Abstracts of Instructional Materials in Vocational and Technical Education, (Columbus, Ohio: Center for Vocational and Technical Education, O.S.U., 1972)

Abstracts of Research Materials in Vocational and Technical Education. (Columbus, Ohio: Center for Vocational and Technical Education, O.S.U., 1972)

Educational Research Service. (Washington, D. C.: American Association of School Administrators and NEA Research Division)

The Environment Index 71, (New York: Environment Information Center, Inc.)

ERIC, Research in Education, (Washington, D.C.: U.S. Dept. of HEW/ Office of Education, National Center for Educational Communication)

Textbooks, Reference Books, Circulars and Manuals

Air Pollution Technology: A Suggested Two-Year Post High School Curriculum Guide, Developed pursuant to a contract with the U.S. Office of Education by the Santa Fe Junior College, Gainesville, Fla. (U.S. Dept. of HEW, Office of Education, 1971), Mimeographed

Babbitt, Harold E. and Baumann, E. Robert, Sewerage and Sewage Treatment. (New York: John Wiley and Sons, Inc., 1958)

Biosphere, The, Readings from Scientific American, (San Francisco: W. H. Freeman and Company, 1970)

Boyer, James F. Jr., "Resumé of Mine Drainage Research Projects," (Monroeville, Pa.: Biruminous Coal Research, Inc., 1968), Mimeographed

Ciac, Orsanco, Papers Presented Before Fourth Symposium on Coal Mine Drainage Research, Pittsburgh, Pa.: Mellon Institute, Apr. 26-27, 1972

Criteria for the Establishment and Maintenance of Two Year Post High School Wastewater Technology Training Programs, Vol. I CEWT Program Criteria, Environmental Protection Agency, Clemson, S. C.: Clemson University, 1970

Dahlsten, Donald L. and Others, Pesticides, (New York: Scientists' Institute for Public Information, 1970)

Dansereau, H. Kirk, Selected Attitudes Toward Highway Change, Monroeville & Blairsville Compared, Institute for Research on Land and Water Resources, State College, Pa.: Pennsylvania State University, 1964

Ehrlich, Paul R. and Anne H., Population Resources Environment, (San Francisco: W. H. Freeman and Company, 1970)

Ehrlich, Paul R., Holdren, John Pr., Holm, Richard W., Commentarians, Man and the Ecosphere, Readings from Scientific American, (San Francisco, W. H. Freeman and Company, 1971)

Eklund, Curtis and Wyss, Orville, Microorganisms and Man. (New York: John Wiley and Sons, Inc., 1971)

Fair, Gordon Maskew; Geyer, John Charles, and Okun, Daniel Alexander, Elements of Water Supply and Wastewater Disposal. (New York: John Wiley and Sons, Inc., 1971)

Fanning, Odom, Opportunities in Environmental Careers, (New York: Universal Publishing and Distributing Corporation, 1971)

Federal Water Pollution Control Administration, Mine Drainage Pollution Control Research and Development Projects, (Cincinnati, Ohio: U. S. Dept. of the Interior, 1968)

Hardenbergh, W. A. and Rodie, Edward B., Water Supply and Waste Disposal (Scranton, Pa.: International Textbook Company, 1970)

Hill, Ronald D., Mine Drainage Treatment State of the Art and Research Needs, (Cincinnati, Ohio: U. S. Dept. of the Interior, Federal Water Pollution Control Administration, Mine Drainage Control Activities, 1968)

Home Sewage Disposal Methods and Techniques, Special Circular 92 (State College, Pa.: Pennsylvania State University, College of Agriculture)

Lavaroni, Charles W. and O'Donnell, Patrick A., Air Pollution, (Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1971)

Lavaroni, Charles W. and O'Donnell, Patrick A., Noise Pollution, (Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1971)

Lavaroni, Charles W. and O'Donnell, Patrick A., Water Pollution, (Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1971)

Leadley, Dr. Samuel M. and Others, Water Resource Problems in Pennsylvania (Institute for Research on Land and Water Resources, State College, Pa.: Pennsylvania State University)

Logan, John A., Oppermann, Paul, and Tucker, Norman E., editors, Environmental Engineering and Metropolitan Planning, (Evanston, Illinois: Northwestern University Press, 1962)

Long, Wesley H.; Kardos, Louis T., and Sopper, William E., Reprint Series # 12, 17, 18, 23 (Institute for Research on Land and Water Resources, State College, Pa.: Pennsylvania State University)

Lund, Herbert F., Editor, Industrial Pollution Control Handbook, (New York: McGraw-Hill Book Company, 1971)

Mager, Robert F., Preparing Instructional Objectives, (Belmont, California: Fearon Publishers, 1962)

Manual of Instruction for Sewage Treatment Plant Operators, New York State Dept. of Health, Office of Education, Division of Environ. Health Services, Office of Public Health Education, Water Pollution Control Board (New York: Health Ed. Service)

Manual of Instruction for Water Treatment Plant Operators, Albany, N. Y.: New York State Dept. of Health

Mine Spoil Potentials for Water Quality and Controlled Erosion, Division of Plant Sciences, W. V. U., Project No. 14010 EJE (Morgantown, West Virginia, West Virginia University: 1971)

Morgan, James J., Editor, Environmental Science & Technology, Vol. 6, No. 4, Apr. 1972 (Washington, D.C.: American Chemical Society)

Morgan, James J., Editor, Environmental Science & Technology, Vol. 6, No. 4, Mar. 1972 (Washington, D.C.: American Chemical Society)

Nadler, Allen A. and Others, Air Pollution, (New York: Scientists' Institute for Public Information, 1970)

Nordell, Eskel, Water Treatment for Industrial and Other Uses, (New York: Van Nostrand Reinhold Company, 1961)

Pratt, Arden L., Environmental Education in the Community College, (Washington, D.C.: American Association of Junior Colleges, 1971)

Recommended Standards for Sewage Works, A Report of Committee of the Great Lakes - Upper Mississippi River Board of State Sanitary Engineers, 1971 Revised Edition, (New York: Health Education Service)

Research Publications, Institute for Research on Land and Water Resources. State College, Pa.: The Pennsylvania State University. No's. 44, 54, 55, 62, 63

Research Publication No. 66 (Institute for Research on Land and Water Resources, State College, Pa.: Pennsylvania State University)

Scientific American Offprints, 1970 Catalogue (San Francisco, California: W. H. Freeman and Company, 1970)

Shreir, L. L., Ph. D., F. R. I. C., F. I. M., Editor, Corrosion, Vol. I (New York: John Wiley and Sons, Inc., 1963)

Shreir, L. L., Ph. D., F. R. I. C., F. I. M., Editor, Corrosion, Vol. 2, (New York: John Wiley and Sons, Inc., 1963)

Simplified Laboratory Procedures for Wastewater Examination, Laboratory Manual for Operators Committee, WPCF Publication No. 18, (Washington, D.C.: Water Pollution Control Federation, 1971)

Simplified Procedures for Water Examination, American Water Works Association, Inc., AWWA Manual M12, (New York: American Water Works Assn., Inc., 1964)

Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc.,; American Water Works Assoc., and the Water Pollution Control Federation, (Washington, D.C.: American Public Health Assn. 1971)

Stern, Arthur C., Editor, Air Pollution. Vol. I (New York, London: Academic Press, 1968)

Stern, Arthur C., Editor, Air Pollution. Vol. II (New York, London: Academic Press, 1968)

Stern, Arthur C., Editor, Air Pollution. Vol. III (New York, London: Academic Press, 1968)

Vennard, John K., Elementary Fluid Mechanics, 4th Edition (New York: John Wiley and Sons, Inc., 1961)

Wastewater Treatment Plant Operator Training Course One. (With Visual Aids), Committee on Personal Advancement, WPCF Publication No. 13, (Washington, D.C.: Water Pollution Control Federation, 1966)

Water and Wastewater Technology, A Suggested 2-Year Post High School Curriculum, U. S. Superintendent of Documents (Reprint), Technical Education Program Series No. 11 (Washington, D.C.: U. S. Government Printing Office, 1968)

Appendix G

Summary of TIME Scheduling

Project Hardware Requirements

Admiral Peary Vocational Technical School

SUPERINTENDENT
F. K. SHIELDS

P. O. BOX 86
EBENSBURG, PENNSYLVANIA 15931
PHONE 472-6490 or 472-6491

DIRECTOR
BRYAN V. FLUCK

Operating Committee Meets:
1st Thursday of the Month
at 7:30 p.m.

SUMMARY OF HARDWARE PROPOSAL
REQUIREMENTS AND BACKGROUND

The Dictionary of Occupational Titles, Third Edition, lists over 20,000 occupational descriptions and over 35,000 occupational titles. The enormity of the possible occupational choices of the individual, coupled with the many individual factors involved in occupational choice, has presented a formidable obstacle to both the individual and the counselor in career counseling. The computer with its vast memory capacity and rapid speed of exploring its own memory can and should be used to assist both counselor and the individual in selecting and planning career goals. The Admiral Peary Area Vocational-Technical School research project on flexible modular scheduling has as its chief goal the development of a computer oriented system for coordinating occupations listed in the Dictionary of Occupational Titles with educational modules in each vocational-technical curriculum, such that individualized programs of study can be tailored to satisfy the career aspirations of each individual. The strategy for the project covers two major areas, that of hardware coordination and that of software development.

In order to develop software, the first steps taken have been to analyze the 20 programs of study to be offered at the Admiral Peary School in terms of educational modules that vary from one to twenty-three weeks in duration. The next step was to list approximately 2,500 occupational titles obtained from a local labor market analysis sponsored by Admiral Peary Area Vocational-Technical School. Each occupational title in turn will be specified in terms of the educational modules previously described. A typical three-year training program in the vocational-technical school will consist of approximately 50 such modules on the average. Thus, as an individual with his counselor decides on his occupational goal, it will be a relatively simple matter in most cases to specify a Dictionary of Occupational Titles code number which in turn is related to a suggested program of study that the individual should follow to satisfy that goal. Individuals will be allowed to proceed through the educational modules at their own rate, such that students finishing modules early will be allowed to proceed to other educational modules. Conversely, students not finishing a module in a specified time will be rescheduled in that module so that they may finish it satisfactorily. The initial project, involving three grade levels, 20 major program areas and approximately 800 students aspiring for the most part for any of approximately 2,500 occupations, presents an enormous challenge for both scheduling and record keeping. The possibilities involved are not unlike those in a chess game where each move presents a whole different array for future moves. A great deal of systems analysis and computer programming has been undertaken to make these goals compatible with the capabilities of the computer that will be used for instructional purposes in the data processing curriculum of the school.

The hardware requirements go beyond that found in the typical data processing instructional area. Data entry stations in each classroom will be used to allow students and teachers to transmit module information data to an intermediate storage unit or buffer which in turn will transmit the data to the central processing unit in the instructional area during those fractions of a second that the central processing unit is at a pause in instructional usage. Additional storage facilities beyond that necessary for instructional purposes are necessary for the vast amount of research data being collected on each student in relation to his career aspirations and program of study.

E.H. Lareau
1/20/72

Appendix H

Curriculum Outline

Unit 1

Module 1.1 TYPES OF POLLUTION

Objective To obtain an understanding of the principle types of pollution, their sources, what is being done in the control and abatement of pollution in the water, air, and soil.

Suggested Prerequisites
General Science
Algebra I

Approximate Time
10 hours

1.1.1 Examine contaminated water specimens and prepare a list of common pollutants found in ground water, surface water, and waste water.

1.1.2 Write a report describing types and sources of atmospheric pollutants.

1.1.3 Indicate a knowledge of solid waste pollution and disposal problems by listing community activities related to control of this form of pollutant.

1.1.4 Perform an on site test to determine extent of thermal pollution emanating from a local thermal source.

1.1.5 Discuss sources of noise pollution in our modern environment.

1.1.6 Summarize in report form an understanding of the principle types of pollution affecting the world environment.

Module 1.2 EFFECTS OF POLLUTION

Objective To obtain a basic understanding of the effects of pollution upon plant, animal and human life on this planet and the historical aspects of pollution.

Suggested Prerequisites
Algebra 1
Biology (Concurrent)

Approximate Time
10 hours

1.2.1 Debate the long range effects of pollution on the ecosphere.

1.2.2 Perform a series of tests where known amounts of pollutant have been introduced to controlled environments such as a pond or green-house. The observed effects of pollution will be listed on a data sheet designed by the student.

1.2.3 Using a salt chamber or a similarly controlled environmental system the student will expose specimens of common metals and alloys to a corrosive atmosphere.

1.2.4 Use an example of social and economic effects of pollution from one of the following sources--mine water effluent, thermal pollution from steel mills, or atmospheric pollution by power plants to develop a socio-economic survey.

1.2.5 Compare the aspects of pollution in the early history of civilization with the problem as it exists in recent years.

Module 1.3 CAREERS IN ENVIRONMENTAL SCIENCES

Objective: To be introduced to the many careers opening up in the environmental services in recent years in the categories of the various types of pollution, - abatement and control.

Suggested Prerequisites
None

Approximate Time
20 hours

1.3.1 Discuss a listing of possible careers with career resource personnel.

1.3.2 Discuss career opportunities with an official of the environmental protection agency.

1.3.3 Discuss career opportunities with local industries employing environmental technicians involved in solving problems related to pollution and corrosion.

Module 1.4 INDUSTRIAL ORGANIZATIONS, INSTITUTIONS AND GOVERNMENT

Objective: Describe and analyze the roles of labor and management in the economy of the industrial society of the United States.

Suggested Prerequisites
None

Approximate Time
10 hours

1.4.1 Name the labor organizations and unions in the industrial world and the objectives and practices of each.

1.4.2 Describe the role of management in our society and the part management plays in industry.

1.4.3 Describe the process of collective bargaining.

1.4.4 Describe the difference between wages and salary and describe the wage and hour laws. Describe the problem of inflation.

1.4.5 Explain the function of the Environmental Protection Agency, the history of the E.P.A. and describe the regulatory power of this organization.

Unit 2

Module 2.1 METHODS OF MEASUREMENT

Objective: To obtain a working knowledge of the various methods and units of distance measurement, size of objects, quantities, pressures and performances used in the engineering and industrial world.

Suggested Prerequisites
Plane Geometry (Concurrent)
Algebra I

Approximate Time
20 hours

2.1.1 To learn to use an engineers scale to find the length of a line on a given plan or map of known scale, such as 1 inch=50 feet.

2.1.2 To be able to use the various formula to compute the volumes of the more common geometric figures used in liquid containers, solids containers and other quantity measuring containers.

2.1.3 To be able to use a planimeter to measure the area of a given irregular shaped object on a plan or map. To be able to compute the area of a geometric shaped object by sub-dividing the area into rectangles, triangles, and/or segments of circles and summing up these individual areas.

2.1.4 To know the metric system of weights and measures and to be able to convert the metric units of measurement to English units and the metric units of weights to Avoirdupois units.

2.1.5 To read digital units of pressure, volume, and flow measurements from single gauges and dials. To read a combination of multi-gauges and/or multi-dials connected together to furnish one quantity of measurement.

2.1.6 To interpret and/or to produce graphs and charts to indicate a specific unit of measurement given certain other parameters and conditions.

2.1.7 To understand the characteristics of certain digital electronic instruments and how they are used to measure distances, areas, volumes and other quantities in use today in industry, laboratory, and engineering.

2.1.8 Perform measurements using micrometers, vernier calipers, and steel rule.

2.1.9 Use of the microscope as an optical comparator and measuring device.

Module 2.2 SURVEYING - FIELD

Objective: To measure angles, distances, and elevations with use of specified surveying instruments to a designated accuracy according to the capabilities of the surveying instruments involved and to record these measurements in an acceptable manner in a surveying Field Book.

Suggested Prerequisites
- Plane Geometry
- Trigonometry
- Algebra II (Concurrent)
- 2.1
- 2.5

Approximate Time
30 hours

2.2.1 To chain (measure) a horizontal distance to a survey accuracy of 1:10,000 with use of a surveyors chain, chaining pins, plumbbobs, tension handles and range poles, using proper hand signals.

2.2.2 To measure a horizontal angle in degrees, minutes, and seconds with use of a surveyors transit, tripod and plumbbobs to the accepted accuracy of the instrument involved. To measure a vertical angle with the same transit to accepted accuracy in degrees, minutes and seconds. To understand the use of verniers, bearings, surveyors compass and the use of proper hand signals in the measurement of angles.

2.2.3 To setup and measure vertical distances or differences in elevation to the nearest .01 foot with use of a surveyors level, tripod, Philadelphia Rod, and proper hand signals. To use these measurements to determine profile elevations, cross section elevations, and elevations of random points.

2.2.4 To take horizontal, vertical, and topographical field data and record the data in proper form in standard surveying field books in a neat and orderly manner.

2.2.5 To measure distances and angles to the accepted accuracy of the electronic measuring instrument such as geodometer and tellurometer.

Module 2.3 SURVEYING - OFFICE

Objective: To develop and understand topographic and contour maps, property plats and deeds, and to reduce raw field notes into a usable form for map plotting, cross section, and profile plotting.

Suggested Prerequisites
- 2.2
- 2.5
- Solid Geometry (Concurrent)

Approximate Time
40 hours

2.3.1 To read and interpret topographical map symbols and lines. To accurately calculate distances, bearings and angles, given sufficient control and scales, using map features. To determine the locations of valleys, ridges, direction of water run off and spot elevations thru examination of contour maps.

2.3.2 To use field notes and data obtained at Court House and in field to prepare a property plat and write a deed description satisfactory for recording at Court House. To identify symbols and conventions used on property plats. To write a deed description using the proper and accepted terminology synonymous with deed descriptions.

2.3.3 To reduce raw vertical & horizontal field notes into acceptable form to be used for plotting of profiles, cross sections, angles, and distances.

2.3.4 To develop contour lines on a map by interpolation from plotted cross sections, from reduced stadia notes, or from a grid type survey.

Module 2.4 SURVEYING - COMPUTATIONS

Objective: To perform surveying computations necessary to develop horizontal curve data; traverse closure, balance, and area. To compute profile grade line elevations and spot elevations from stadia computations.

Suggested Prerequisites
2.3
2.5

Approximate Time
30 hours

2.4.1 To perform the computations necessary to establish horizontal curve data sufficient to properly layout curve in field. Given a central angle and a radius, compute the tangent distance, length of curve, degree of curvature, external distance, and deflection per foot of curvature.

2.4.2 To perform the computations to properly close a traverse, compute error of closure, both angular and distance; to compute the area enclosed by the Double Meridian Distance Method.

2.4.3 To perform and tabulate the computations to properly balance a survey closure - both angular and distance.

2.4.4 To perform the computations for a final profile grade line of a highway, sewer line, or drainage ditch including tangent grades and vertical curve computations to establish final elevations at a set horizontal distance interval of every 25 feet.

2.4.5 To reduce stadia field notes to a usable form permitting spot elevations to be plotted using azimuth, distance and elevations from a given point or location. To plot these spot elevations sufficiently well to develop accurate contour lines by interpolation.

Module 2.5 TECHNICAL DRAFTING

Objective: To develop an understanding of the functions of drafting in industry. To develop basic skills and techniques in the use of drafting equipment and to provide the student with the means of graphically expressing himself in the areas fundamental to all engineering.

Suggested Prerequisites
Plane Geometry
Trigonometry (Concurrent)
2.1

Approximate Time
20 hours

2.5.1 To learn the techniques of drafting and to use the various drafting instruments to produce required engineering drawing techniques.

2.5.2 To know planimetric and topographic symbols, features and fundamentals, so that these items can be understood and recognized when required on drawings.

2.5.3 To plot to assigned horizontal and vertical scales profiles and cross sections of several lines plotted on a given contour map or from a set of field notes.

2.5.4 To know map symbols and to demonstrate ability to show the various rock and mineral strata in both plan and profile views for a geological map presentation. To be able to plot core borings, and soil profiles from a set of geological field notes.

2.5.5 To understand the 3 basic planes used in orthographic projection and how to project the views and dimensions of a 3 dimensional object on any one of the planes.

Module 2.6 BLUEPRINT READING

Objective: Elementary Blueprint reading for beginners in Engineering and Related Technologies. To be able to visualize a structure or object in three dimensions as represented by a blue print in three views. To understand drawing conventions, symbols, and notes and to interpret the proper construction details necessary to produce a finished product as shown on the blueprint.

Suggested Prerequisites
2.5

Approximate Time
10 hours

2.6.1 To recognize, identify and name the conventional lines in construction drawings.

2.6.2 To interpret one, two, and three view drawings, place the views in proper position and to write the correct answers to selected questions concerning the description of a given construction figure shown on a blue print.

2.6.3 To interpret fractional, decimal, and angular dimensions and scales and to be able to write answers to questions about dimensions for a given blueprint.

2.6.4 To recognize and name all types of drilled, reamed, bored, counterbored, countersunk and tapered holes.

2.6.5 To recognize and interpret standard thread representations.

2.6.6 To recognize and interpret fractional, decimal, and angular tolerance dimensions.

2.6.7 To recognize and interpret information contained in the title block.

2.6.8 To recognize and interpret information contained in the construction notes and leaders by answering written questions concerning a given blueprint.

2.6.9 To recognize and interpret symbols for surface finishes.

2.6.10 To become familiar with methods for reproducing engineering line drawings.

2.6.11 To become familiar with standard drafting procedures for filing and storage of prints.

Module 2.7 REPORT WRITING

Objective: The student will write effective descriptions, definitions, analyses, as well as a short report using a proper outline and effective non-verbal elements of report writing.

Suggested Prerequisites
English I or Equivalent

Approximate Time
20 hours

2.7.1 To write a general and a restricted definition for any piece of equipment; for any organization; and for the subject of any abstract idea.

2.7.2 To write a description of how any piece of equipment; any organization; and the subject of any abstract idea is organized and how it functions.

2.7.3 To write a list of categories for a group of pieces of equipment; organizations; and subjects of an abstract idea.

2.7.4 To write an outline of the major sections of a technical report.

2.7.5 To write a discussion of the advantages and disadvantages of using non-verbal elements such as layout, headings, paragraphing, charts and graphs.

2.7.6 To write a technical report approximately 750 words in length on any subject related to the "world of work", employing the major elements of technical writing.

Module 2.8 CODES, CONTRACTS, SPECIFICATIONS, AND ESTIMATES

Objective: To demonstrate a knowledge of the basic fundamentals of national and local building codes; the elements and legal aspects of contracts and construction specification writing; and the mechanics of preparing estimates of material, labor, detailed cost estimates.

Suggested Prerequisites	Approximate Time
2.6	20 hours

2.8.1 To demonstrate an understanding of the national and local building codes; and the function of each in a local community.

2.8.2 To demonstrate an understanding of the basic elements of contract writing and to explain the legal aspects involved in contract writing.

2.8.3 To demonstrate an understanding of the proper methods and terminology used in specification writing.

2.8.4 To demonstrate ability to accurately prepare estimates of labor, material, equipment, costs, overhead, and profit.

Unit 3

Module 3.1 PROBABILITY IN SAMPLING

Objective: To demonstrate intelligence in collecting samples including when to use random or nonrandom sampling.

Suggested Prerequisites
Algebra I & II

Approximate Time
20 hours

3.1.1 To illustrate the initial aspect of intelligent sampling including elementary statistics of sample collecting and a thorough understanding of the basis of collecting representative samples.

3.1.2 To distinguish between random and non-random sampling.

3.1.3 To observe the difference between random and non-random sampling using hypothetical sampling situations with each of gases, solids, and liquids.

Module 3.2 AIR SAMPLING

Objective: To demonstrate the proper methods of gas and particulate sampling of the air.

Suggested Prerequisites
3.1
General Science (Earth Science)

Approximate Time
10 hours

3.2.1 To discuss all aspects of gas and particulate collection and sampling including collection methods and equipment, sample storage and preservation, sampling techniques and safety factors involved in gas collection.

3.2.2 To perform an exercise of collecting an air sample, and preserving the sample, to avoid chemical change for a sample pollutant such as carbon monoxide or sulfur dioxide.

Module 3.3 WATER SAMPLING

Objective: To demonstrate the proper sampling methods, preservation, storage, and on-site analysis of ground water, surface water, and waste water.

Suggested Prerequisites
3.1
General Science (Earth Science)

Approximate Time
10 hours

3.3.1 To discuss the collection methods of ground, surface and waste water samples to insure that it is a representative sample.

3.3.2 To demonstrate the proper techniques of water sample preservation including ferrous ion in mine drainage, sterile requirements for B.O.D. samples and the use of chemical "fixatives" in sample preservation.

3.3.3 To collect a representative sample of ferrous iron in acid mine drainage and to perform on-site analysis of the sample as well as subsequent lab. analysis to fully appreciate the need for practicing proper sample preservation methods.

Module 3.4 SOLIDS SAMPLING

Objective: To demonstrate the proper methods of solid sampling techniques according to A.S.T.M. procedures.

Suggested Prerequisites
3.1
General Science (Earth Science)

Approximate Time
10 hours

3.4.1 To discuss in depth the A.S.T.M. solid sampling techniques with special emphasis placed on sample identification, storage, and preservation.

3.4.2 To prepare a solid unknown sample according to A.S.T.M. procedures for preservation and storage demonstrating the inaccuracies which result when moisture is lose from the sample.

Module 3.5 **MISCELLANEOUS SAMPLING**

Objective: To discuss and perform various types of miscellaneous sampling.

Suggested Prerequisites
3.1
General Science (Earth Science)

Approximate Time
10 hours

3.5.1 To discuss or illustrate the many possible instances of miscellaneous sampling; an example being the refuse in a bottle of carbonated beverage.

3.5.2 To write a procedure for miscellaneous sampling with group discussion pointing out the weaknesses and merits of the individual approach.

Module 3.6 **WEIGHING BALANCE**

Objective: To weigh an object of unknown weight to acceptable accuracy of the balance, to learn how to care for and maintain a balance scale.

Suggested Prerequisites
2.1

Approximate Time
10 hours

3.6.1 To discuss the principles of the weighing balance operation including the care and maintenance of the scales.

3.6.2 To become familiar with electronic weighing instruments such as Mettler precision type balance, their capabilities, care and maintenance of the instruments.

3.6.3 To become familiar with other balances such as triple beam balances, their capabilities, care and maintenance.

3.6.4 To determine the exact weights of several unknowns within the accuracy limits of the weighing instrument prescribed.

3.6.5 To practice using the balance scales until completely familiar and competent in determining weights of various unknowns, within the accepted accuracy of the weighing instrument.

3.6.6 Become familiar with industrial methods of weighing using conventional and electronic techniques.

Module 3.7 PHILOSOPHY OF SCIENCE AND RESEARCH

Objective: To understand that science and research are not random but methodical approaches to the identification and solution to a problem.

Suggested Prerequisites
None

Approximate Time
10 hours or less

3.7.1 To choose a hypothetical research project in weighing or sampling.

3.7.2 Prepare an outline or discussion as to how students could carry out a chosen research project.

Unit 4

Module 4.1 ATOMIC ABSORPTION/FLAME EMISSION

Objective: To learn the theory, operation, and interpretation of the data for the Atomic Absorptional Flame Emission Instrument.

Suggested Prerequisite
Chemistry
Physics (Concurrent)

Approximate Time
10 hours

4.1.1 To discuss the theory of Atomic Absorption and Flame Emission including applications and limitations of techniques.

4.1.2 To prepare a sample for analysis with special attention to the sensitivity of techniques.

4.1.3 To calibrate the Atomic Absorption instrument for proper analysis of trace metals.

4.1.4 To determine the proper selection and use of gases in the Atomic Absorption analysis.

4.1.5 To describe the "role" of lamps, their selection, and care in the Atomic Absorption analysis.

4.1.6 To operate the Atomic Absorption instrument to perform analysis of an unknown containing several commonly found ionic species.

4.1.7 To properly interpret data results, including discussion on methods of graphical presentation.

Module 4.2 VISIBLE/U.V. SPECTROMETER

Objective: To understand the basic principles of light absorption and the applications of spectrometers. To prepare a sample for spectrometry and to demonstrate the operation of the U.V. Spectrometer.

Suggested Prerequisites
Physics (Concurrent)

Approximate Time
10 hours

4.2.1 To discuss the basic principles of light absorption (Lambert-Beer Law) and to define important terms such as wave length, visible, ultra-violet, etc.

4.2.2 To define the limitations and applications of techniques of spectrometers.

4.2.3 To prepare a sample for spectrometry with particular emphasis on accuracy, cleanliness of glassware, and selection of "color generators".

4.2.4 To demonstrate the operation of a U.V. spectrometer with a sample containing several applicable cations and anions to be identified by the student.

4.2.5 To determine the optimum wave-lengths for individual ionic species (Transmittance vs. Wave Length Curves.)

4.2.6 To interpret the data obtained from the use of the spectrometer.

Module 4.3

pH METER

Objective: To explain the principle of the pH meter and to demonstrate the operational procedures.

Suggested Prerequisites
Algebra II
Chemistry

Approximate Time
10 hours

4.3.1 To define the term "pH" and the use of the pH number to determine if a solution is acid or base.

4.3.2 To explain the operation of the pH meter including the function and care of the electrodes.

4.3.3 To demonstrate the operational procedures of a pH meter to measure the true degree of acid or alkalinity.

4.3.4 To demonstrate the operational procedures for preparation of standard buffers.

4.3.5 To demonstrate the operational procedure to standardize the pH meter.

4.3.6 To demonstrate the temperature effect on the use of the pH meter and scale.

4.3.7 To demonstrate the use of the meter to measure several of unknowns on pH's in both the acidic and basic regions.

Module 4.4

KJELDAHL APPARATUS

Objective: To discuss the KJELDAHL Technique for testing nitrogen compounds including operation and measurement of KJELDAHL Nitrogen.

Suggested Prerequisites
Biology

Approximate Time
10 hours

4.4.1 To discuss the nitrogen compounds and the applications and limitations of the KJELDAHL technique of testing.

4.4.2 To be familiar with other techniques that are available to provide additional information concerning nitrogen compounds.

4.4.3 To be completely familiar with the KJELDAHL apparatus set-up, the use of reagents with the apparatus and the effects of temperature.

4.4.4 To measure a predetermined amount of KJELDAHL Nitrogen.

Module 4.5

OXYGEN ANALYZER

Objective: To discuss the use of oxygen analyzers to measure mixtures of oxygen in gases or water, but not in its compounded form. To demonstrate the procedure for operating, and oxygen measurement using the oxygen analyzer.

Suggested Prerequisites
Chemistry
Biology

Approximate Time
10 hours

4.5.1 To discuss the use of the oxygen analyzer to measure amount of free oxygen in mixtures of water or other gases.

4.5.2 To demonstrate an operating knowledge of the oxygen analyzer, including scale selection, scale reading, and calibration.

4.5.3 To measure sample oxygen mixtures such as air or water using the oxygen analyzer.

Module 4.6 WET GAS METER

Objective To demonstrate the principle of the Wet Gas Meter, its operation, and the measurements that can be made with the Wet Gas Meter.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.6.1 To discuss the principles of wet gas meter operation, capabilities and uses.

4.6.2 To operate a wet gas meter including connection of meter, leveling of meter, and pre-conditioning the gas such as drying or cleaning the gas.

4.6.3 To measure the gas accurately using the gas meter at various flow rates.

Module 4.7 GAS CHROMATOGRAPHY

Objective To demonstrate the principle of gas chromatography including apparatus set-up and operating procedure.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.7.1 To discuss the principle of gas chromatography for both separation and analysis.

4.7.2 To understand the limitations of the Gas Chromatograph.

4.7.3 To assemble the apparatus in preparation for gas separation and analysis.

4.7.4 To understand the use of metering controls in gas chromatography analysis.

4.7.5 To select the proper carrier gas for the chromatography.

4.7.6 To properly precondition the sample for analysis.

4.7.7 To select the proper chromatographic columns and properly prepare the columns for a prescribed analysis.

4.7.8 To perform the separation of a mixture of gases and to correctly perform an analysis of each of the fractions of gases.

Module 4.8 KARL FISCHER APPARATUS

Objective: To demonstrate the principle of Titration and the use of the Karl Fischer Apparatus for automatic titration including set-up and operational procedure.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.8.1 To discuss the principle of titration.

4.8.2 To explain how Karl Fischer Apparatus is used for automatic titration.

4.8.3 To demonstrate the set-up of the Karl Fischer Apparatus and to demonstrate the operation procedure for automatic titration.

4.8.4 To demonstrate competency in the set-up, operation, and cleaning of the Karl Fischer Apparatus.

Module 4.9

AIR SAMPLER

Objective: To demonstrate the use of Air Samples and the principles of light transmittance including operating procedure and particulate measurement.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.9.1 To discuss the principle of light transmittance in connection with the air sampler instrument.

4.9.2 To set-up and operate the air sampler correctly.

4.9.3 To demonstrate the maintenance and care of the recorder and measuring cell for the air sampler.

4.9.4 To obtain a field sample of air and record the air quality using the Air Sampler.

Module 4.10

WATER POLLUTION KITS

Objective: To demonstrate the use of various types of water pollution kits such as Color Comparators, reagent type kits and to know the relative accuracy and sensitivity of the kit involved in comparison to specific laboratory tests.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.10.1 To discuss the use of color comparator, indicators, and reagent techniques common to the water pollution kits used to sample and test water in the field.

4.10.2 To be familiar with the relative degree of accuracy and sensitivity possible with the use of the kind of kit.

4.10.3 To analyze a sample of polluted water correctly to the relative accuracy of the pollution kit involved; and to test the sample with other laboratory instruments to verify the pollutants found with the water pollution kit.

Module 4.11 SULFUR DIOXIDE COUNTER

Objective: To demonstrate the principle, set-up and operation of the sulfur dioxide counter and dustfall bucket.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

4.11.1 To discuss the principle of the sulfur dioxide counter and dustfall determination..

4.11.2 To properly set up the counter at an approved site in the field.

4.11.3 To correctly measure the SO_2 and dustfall at a field set-up of the sulfur dioxide counter.

Unit 5

Module 5.1

CENTRIFUGE

Objective: To demonstrate the principle of a centrifuge, its use, and operational procedure.

Suggested Prerequisite
General Science

Approximate Time
10 hours

5.1.1 To explain the principle of centrifugal force and how it is used in mixture separation.

5.1.2 To demonstrate how to operate a centrifuge, and how to select the proper assessories to use with the centrifuge.

5.1.3 To demonstrate competency of how and when to use a centrifuge.

Module 5.2

MANOMETER

Objective: To demonstrate the principle of the manometer and how it is used to measure pressure, using various liquids, such as mercury or water.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.2.1 To explain the principle of a manometer and how it is used with liquids such as mercury or water to measure pressures.

5.2.2 To set up the manometer, and to adjust sliding scale according to level of liquid to measure difference between total pressure and gauge pressure.

5.2.3 To explain why it is necessary to have a sliding scale to get accurate pressure measurements using a manometer.

5.2.4 To use a manometer to measure accurately the pressure of a gas which has a known pressure.

Module 5.3 GLOVE BOX

Objective: To demonstrate the principle and uses of a glove box for handling materials that must be confined.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.3.1 To discuss the principle and uses of a glove box.

5.3.2 To demonstrate the proper use of a glove box in handling materials that must be confined.

Module 5.4 SPECIFIC GRAVITY BALANCE

Objective: To determine the difference between density and specific gravity and to use a specific gravity balance to determine the specific gravity of a solid by weighing methods.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.4.1 To discuss the relationship between specific gravity and density.

5.4.2 To explain the method of determining specific gravity of solids by weighing methods using a specific gravity balance.

5.4.3 To demonstrate the procedure of determining a specific gravity of an unknown using the specific gravity balance.

Module 5.5 HYDROMETER

Objective To demonstrate the procedure for determining the specific gravity of a liquid by the use of a hydrometer on various ranges of hydrometers.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.5.1 To discuss the method and procedure for determination of liquid specific gravities by use of hydrometers of various ranges available.

5.5.2 To demonstrate the procedure and operation of a hydrometer to determine the specific gravity of several unknowns.

Module 5.6 PYCNOMETER

Objective To demonstrate the procedure for determining the density of a solid by use of a pycnometer and the effects of temperature on the density determination.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.6.1 To discuss the method and procedure for determination of density of a solid by use of a pycnometer including the effect of temperature.

5.6.2 To demonstrate the operation of a pycnometer including the cleaning, filling, and weighing of the pycnometer.

5.6.3 To determine the density of an unknown solid by use of a pycnometer correcting for the temperature of the solid.

Module 5.7 VISCOMETER

Objective To demonstrate a thorough understanding of the term viscosity, the effect of temperature, and the use of the viscometer to measure the viscosity.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.7.1 To explain thoroughly what is meant by the term viscosity and to explain the effect of temperature on the unit of measure of viscosity.

5.7.2 To demonstrate the procedure and operation of the viscometer to measure the viscosity including the correction for temperature.

5.7.3 To use viscometer to measure the viscosity of an unknown liquid, correcting for temperature.

Module 5.8 MICROSCOPE AND CAMERA

Objective To demonstrate the proper methods and procedures to use a microscope, microscopic slides and camera attachment and to be familiar with examples of various elements under microscope.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.8.1 Introduce the student to the optical consideration involved in microscopy and photomicrography.

5.8.2 In addition to a reasonable understanding of the limitations and capabilities of the microscope, the use of an efficient source of illumination should be considered in detail.

5.8.3 Demonstrate the use of various cameras and microscope accessories.

5.8.4 The student will use a variety of films and filters to produce accurate photographic images.

effect of temperature, and the use of the viscometer to measure the viscosity.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.7.1 To explain thoroughly what is meant by the term viscosity and to explain the effect of temperature on the unit of measure of viscosity.

5.7.2 To demonstrate the procedure and operation of the viscometer to measure the viscosity including the correction for temperature.

5.7.3 To use viscometer to measure the viscosity of an unknown liquid, correcting for temperature.

Module 5.8 MICROSCOPE AND CAMERA

Objective To demonstrate the proper methods and procedures to use a microscope, microscopic slides and camera attachment and to be familiar with examples of various elements under microscope.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.8.1 Introduce the student to the optical consideration involved in microscopy and photomicrography.

5.8.2 In addition to a reasonable understanding of the limitations and capabilities of the microscope, the use of an efficient source of illumination should be considered in detail.

5.8.3 Demonstrate the use of various cameras and microscope accessories.

5.8.4 The student will use a variety of films and filters to produce accurate photographic images.

5.8.5 Determine exposures using at least (3) types of exposure calculators.

5.8.6 Discuss the utilization of the microscope for specialized techniques. Examples: 1. Dark-Field Illumination. 2. Interferometry. 3. Polarized light, etc.

5.8.7 Indicate proper operation and maintenance procedures for laboratory microscopes.

Module 5.9 ELECTROSTATIC PRECIPITATOR

Objective: To discuss the use of electrostatic precipitators to remove smoke particulates from stack emissions and to demonstrate an understanding of the principles of operation involved.

Suggested Prerequisites
Physics (Concurrent)

Approximate Time
10 hours

5.9.1 To know what an electrostatic precipitator is used for, and the principles involved in removing particulates from stack emission.

5.9.2 To demonstrate by laboratory experiment, the use of electrostatic precipitators to remove particulates from stack emissions.

5.9.3 To observe a commercial electrostatic precipitator in operation and to determine the amount of fly ash removed by this precipitator.

Module 5.10 B.O.D. MANOMETER

Objective: To explain the term Biochemical Oxygen Demand, (B.O.D.) how it is measured, what is indicated by the amount of B.O.D., and to use the B.O.D. Manometer to measure the B.O.D.

Suggested Prerequisites Biology	Approximate Time 10 hours

5.10.1 To demonstrate a thorough understanding of the term "Biochemical Oxygen Demand."

5.10.2 To determine the amount of "B.O.D." in a water sewage sample using a B.O.D. Manometer.

5.10.3 To determine the amount of B.O.D. in a water sewage sample using the modern "Standard Dilution" method as used in most laboratories today.

Module 5.11 TURBIDIMETER

Objective To demonstrate a thorough understanding of the term turbidity as distinguished from other similar parameters, and to examine the turbidity with a turbidimeter and compare results with other tests such as colorimetry.

Suggested Prerequisites General Science	Approximate Time 10 hours

5.11.1 To discuss in-depth the meaning of the word turbidity and to distinguish the term from other seemingly similar parameters.

5.11.2 To set up a turbidimeter station and to operate the turbidimeter to calibrate a set of standards for the measurement of the critical amounts of turbidity.

5.11.3 To satisfactorily perform the proper maintenance and care of a turbidimeter to assure continued reliable results.

5.11.4 To compare the results obtained with a turbidimeter with those obtained from other reliable sources such as colorimetry and test kit procedures.

Module 5.12 SALT-SPRAY CHAMBER/CORROSION TESTING

Objective: To demonstrate an understanding of the term corrosion and its relation to salt. To operate a salt spray chamber to measure corrosion resistance on a given substance or metal.

Suggested Prerequisites
General Science

Approximate Time
10 hours

5.12.1 Demonstrate the effect of corrosive media on various materials.

5.12.2 Demonstrate procedures for operation and maintenance of controlled environment chambers.

5.12.3 Use the salt-spray chamber to establish the relative merits of different materials in resisting atmospheric attack.

5.12.4 Consult 1951 ASTM Marburg Lecture entitled "Corrosion Testing" for an understanding of corrosion testing.

Unit 6

Module 6.1 AUTOCLAVE

Objective: To explain how the autoclave is used to thoroughly sterilize small instruments and test tubes in chemical and biological analysis.

Suggested Prerequisites
Biology
Chemistry

Approximate Time
10 hours

6.1.1 To explain the needs of thorough instrument sterilization for precise chemical and biological analysis.

6.1.2 To demonstrate the procedure for handling sterilized instruments to be used for precision analysis.

6.1.3 To set-up and use the autoclave for sterilization of chemical and biological instruments and test tube used in precise analysis.

Module 6.2 INCUBATOR

Objective: To instruct the students in the operation of both low and high temperature incubators, and acquaint them with the laboratory procedures requiring an incubation period.

Suggested Prerequisites
Biology
Chemistry

Approximate Time
10 hours

6.2.1 Low Temperature Incubation - Instruct the students in the use of the low temperature incubator in performing B.C.D. tests and compliment fixation tests.

6.2.2 CO_2 Incubator - To become familiar with the use of the incubator for tissue culturing applications and carbon dioxide obligate organisms.

Module 6.3 COLONY COUNTER

Objective To become proficient in the application and use of the Quebec Colony Counter.

Suggested Prerequisites
Biology

Approximate Time
10 hours

6.3.1 Application - distinguishing between cultures that are adaptable to a colony counter and those that are not.

6.3.2 Technique - to develop a skill in the proper use of the instrument to obtain optimal results.

Unit 7

Module 7.1 OVENS

Objective: To understand the effect of heat on test samples and the use of a combination vacuum oven and dessicator.

Suggested Prerequisites
- Biology
- Chemistry
- Physics (Concurrent)

Approximate Time
10 hours

7.1.1 Sample classification - to teach the student to distinguish between samples that release chemically active vapors and must be vacuum heated, and other samples.

7.1.2 Dessicators - to explain the function of the dessicator and its effect on laboratory samples.

7.1.3 Methods - to train students in the proper use of the combination vacuum oven and dessicator.

Module 7.2 STILL

Objective: To relate the application of the distillation process to specific laboratory procedures and to understand the principle and use of distillation equipment.

Suggested Prerequisites
- Chemistry

Approximate Time
10 hours

7.2.1 Rationale of the distillation process.

7.2.2 Application of the distillation principle as it relates to specific laboratory tests.

7.2.3 Procedure and proper use of distillation equipment.

Unit 8

Module 8.1 COMPONENT PRESSURES AGAINST SUBMERGED SURFACES

Objective: To describe, measure, and calculate the various component pressures against submerged surfaces.

Suggested Prerequisites
General Science
Algebra I & II
Trignometry
Physics (Concurrent)

Approximate Time
20 hours

8.1.1 To define the following basic terminology used in liquid pressure measurement: hydrostatics, definition of a liquid, pressure head in irregularly shaped containers, capillary action.

8.1.2 To write answers to questions concerning the following pressure related items: measurement of pressure, units of pressure, atmospheric pressure, gauge pressure, types of instruments used to measure pressure.

8.1.3 To demonstrate ability to measure and describe the following pressure components: Total liquid pressure against submerged surfaces; normal pressure, uniformly distributed pressure, non-uniform pressure, pressure on simple areas, pressure on complex areas, pressures on surfaces with irregular outlines, graphic representation of pressure, components of pressure on inclined surfaces.

8.1.4 Demonstrate ability to locate center of pressure by calculation, or by other means for geometric shaped surfaces.

8.1.5 Demonstrate ability to calculate pressures on sections with liquid on one or both sides, component of pressure on curved surfaces, pressure in pipes, pressure in closed cylinders.

Module 8.2 BOUYANCY AND FLOTATION

Objective To demonstrate an understanding of the various laws and principles of bouyancy flotation.

Suggested Prerequisites
Module 8.1

Approximate Time
20 hours

8.2.1 To perform a demonstration of Archimedes Principle: The vertical bouyant force is equal to the submerged or displaced volume times weight per unit volume of the liquid. To show how the forces are in equilibrium when a body is in flotation and how the depth of flotation is a function at the bouyant force as well as the water pressure force.

8.2.2 To demonstrate the law: Specific gravity is equal to weights of an object divided by the bouyant force. To demonstrate how a volume of irregularly shaped solid can be found by weighing solid suspended in water. To demonstrate the principles of a hydrometer.

8.2.3 To demonstrate an understanding of stability of flotation, center of bouyance, righting and upsetting moments.

Module 8.3 ORIFICES AND RESTRICTIVE DEVICES

Objective To understand the effects of orifices and other restrictive devices on the flow of liquids.

Suggested Prerequisites
Module 8.1

Approximate Time
20 hours

8.3.1 To explain how the following terms are connected to, related to, or effect the flow of liquids through orifices and other restrictive devices: velocity and discharge, stream-line and turbulent flow, resistance to flow, critical velocity, steady and unsteady flow, uniform flow, non-uniform flow, equation of continuity, and mean velocity.

8.3.2 To demonstrate an understanding of the various kinds of energy developed by water flowing through orifices, by water impounded by a dam, and by water having a hydraulic head.

8.3.3 To explain Bernoulli's theorems of perfect liquid, and actual flow; and to demonstrate the applications of these theorems.

8.3.4 To demonstrate the principles of operation of a venturi-meter, formula for discharge, and practical features of a venturi-meter.

8.3.5 To describe the flow of liquids through orifices, and how flow, pressure, and head can be measured by the use of standard orifices.

Module 8.4 FLOW OF WATER OVER WEIRS

Objective To define a weir and to measure flow of water over various shapes and sizes of weirs.

Suggested Prerequisites
Module 8.1

Approximate Time
20 hours

8.4.1 To write the definition of a weir, to identify a rectangular and triangular weir and a Parshall Flume.

8.4.2 To compute the discharge or flow over weirs by the following methods: Rational formula for rectangular weirs; Francis formulas for rectangular weirs, Basin and Rehbock formula for suppressed rectangular weirs, formulas for triangular weirs, formula for trapezoidal weirs, submerged weirs, and broad crested weirs, to understand the use of weir discharge tables, and the accuracy of weir measurements.

Module 8.5 FLOW OF WATER IN CLOSED CONDUITS

Objective To understand the theory, the equations and computations involved with flow of water in closed conduits.

Suggested Prerequisites
Module 8.1

Approximate Time
30 hours

8.5.1 To understand the theory of the formula for flow in conduits, normal distribution of velocities in cross section of pipes, application of Bernoullis Theorem to pipes and losses of head in pipes.

8.5.2 To identify the following important factors that are used in the computations of pipe flow: (a) The size or diameter of a pipe. (b) the length of pipe in question. (c) the difference between the effective heads at the beginning and end of pipe. (d) mean velocity at outlet of pipe. (e) a roughness coefficient for the inner surface of a pipe.

8.5.3 To identify and to understand the Chezy-Darcy and the Hazen-Williams formulas to compute flow in closed conduits.

8.5.4 To demonstrate the use of the tables and charts used to determine amount of flow for a given size and kind of pipe at a given slope and at a given depth of flow.

8.5.5 To demonstrate an understanding for the following minor hydraulic head losses in connection with water flowing through pipe. (a) Loss at entrance to pipe. (b) Loss due to sudden expansion. (c) Loss at pipe outlet into reservoir. (d) Loss due to gradual expansion or contraction. (e) Loss due to curves in flow. (f) Loss due to flow through water valves. (g) Loss due to various pipe fittings.

8.5.6 To construct the hydraulic grade line for a given pipe on a sheet of graph paper.

Module 8.6 FLOW OF WATER IN OPEN CHANNEL

Objective: To demonstrate a basic understanding of characteristics of water flowing in open channels.

Suggested Prerequisites
Module 8.1

Approximate Time
30 hours

8.6.1 To describe the various types, uses, and cross sections of open channels.

8.6.2 To write and understand the following basic formulas for flow in open channels: (a) To compute velocity of flow. (b) Chezy Formula. (c) Manning's Formula. (d) Hydraulic radius. (e) Slope of hydraulic gradient.

8.6.3 To write and understand the computations for the discharge in open channels for (a) Circular channel section. (b) Rectangular channel section. (c) Trapazoidal channel section.

8.6.4 To demonstrate an understanding of the purpose of stream gauges, types of gauges, method of location of stream gauges and the computation of discharge for a given stream.

Module 8.7 PUMP DESIGN, SELECTION AND CHARACTERISTICS

Objective: To understand the selection and operation of the various types of pumps used in the pumping of liquids.

Suggested Prerequisites
Modules 8.1, 8.3, 8.5

Approximate Time
20 hours

8.7.1 To demonstrate the use of pumps in water treatment plants, water distribution systems, sewage treatment and collection systems; the types of pumps used for each operation such as centrifugal, displacement, air lift pumps, submerged suction, suction lift, and inline pumps.

8.7.2 To demonstrate and understand the operation of displacement pumps, the operation of single acting reciprocating pump, duplex and triplex acting reciprocating pumps, and the application of reciprocating pumps.

8.7.3 To demonstrate an understanding of the characteristics and advantages of the various types of centrifugal pumps, (a) simple (b) multi-stage (c) double suction and (d) turbine pumps.

8.7.4 To demonstrate an understanding of the characteristics and advantages of the air-lift pump.

8.7.5 To demonstrate an understanding of the general design of pumping installations; power for pumping, size of units, cost of pumping, total lift of pump, horsepower required, and measurement of pump discharge.

Module 8.8 RECORDERS AND MEASUREMENT CHARTS

Objective: To demonstrate an understanding of the use of various types of recorders and measurement charts in conjunction with water and sewage treatment plants and distribution systems.

Suggested Prerequisites
Module 8.1

Approximate Time
10 hours

8.8.1 To explain satisfactorily the use of recorders in water distribution systems, water treatment plant operation, sewage collection systems, sewage treatment plant operation, and in conjunction with other measuring devices in open & closed channel flow.

8.8.2 To describe the different types of recorders, continuous 24 hour, intermittent, peak period area, and stationary or portable.

8.8.3 To demonstrate an understanding of continuous strip, circular, digital and combination type charts.

Module 8.9 FLOW CALIBRATION CHARTS

Objective: To demonstrate the ability to use the various flow calibration charts to obtain desirable quantity of flow, velocity of flow, depth of flow, size of pipe, type of pipe, size of open channel.

Suggested Prerequisites
Modules 8.1, 8.3, 8.4, 8.5

Approximate Time
10 hours

8.9.1 To plot flow characteristics on a desirable scale of standard graph paper, logarithmic graph paper and semi-logarithmic graph paper.

8.9.2 To understand and to use the following important charts of flow characteristics: (a) flow charts (b) nomographs (c) weir calibration charts (d) orifice charts (e) proportional velocity (f) QVA charts (g) hydraulic slide rule.

Unit 9

Module 9.1 WATER SOURCES, DEMAND AND STORAGE

Objective: To demonstrate an understanding of the various water sources, types and amount of water demand, and types of water storage.

Suggested Prerequisites
General Science (Earth Science)
Chemistry

Approximate Time
20 hours

9.1.1 To demonstrate an understanding of the various ground and surface water sources, the hydraulics of ground water flow, the yields of shallow and deep wells, well straining, casings and cementing of wells. To demonstrate an understanding of surface water intake structures and pumping arrangements at these intake structures.

9.1.2 To demonstrate an understanding of the water demands for a water system and the conditions influencing these demands such as population forecasting, type and quantities of consumption, the factors affecting consumption, daily and seasonal demand fluctuations, fire demands.

9.1.3 To demonstrate an understanding of the different types of water storage such as reservoirs, elevated tanks, underground storage and the advantages and uses of each system.

Module 9.2 WATER DISTRIBUTION SYSTEMS

Objective: To demonstrate an understanding of the analysis and design of water distribution systems including the pipes used, pumps, and pumping stations.

Suggested Prerequisites
General Science
9.1

Approximate Time
30 hours

9.2.1 To demonstrate a basic understanding of the methods of analysis and design of pipe sizes for a water distribution system including, also, flow in pipes and system appurtenances.

9.2.2 To demonstrate a knowledge of the construction of water distribution systems including pipe disinfection, testing, and thawing of a frozen line.

9.2.3 To demonstrate the use of pumps and pumping stations in connection with water distribution systems for lifting water to storage, system boosting and pumping, and waste water wet wells.

Module 9.3 WATERSHED PROTECTION

Objective: To demonstrate the precautions necessary to assure proper watershed and reservoir sanitation.

Suggested Prerequisites
9.1

Approximate Time
10 hours

9.3.1 To demonstrate the necessity of watershed and reservoir sanitation including restricting the use of watershed and reservoir areas.

9.3.2 To demonstrate how to control and monitor the reservoir and water treatment plants for impurities using standby chlorination.

9.3.3 To explain why it is necessary to exclude all livestock from watershed and, to check for other sanitary concerns such as faulty plumbing, cross connections and pipes.

Module 9.4 AERATION AND SEDIMENTATION TREATMENT

Objective: To demonstrate the purposes and methods of aeration and sedimentation treatment of water.

Suggested Prerequisites
9.1

Approximate Time
20 hours

9.4.1 To demonstrate the purposes, types, and design for aeration treation of water.

9.4.2 To understand the sedimentation methods, design of sedimentation units, and the limitation of settling properties of solids.

9.4.3 To explain the principle of activated carbon treatment of water, the design methods involved, and the regeneration of the activated carbon.

Module 9.5 FILTRATION TREATMENT OF WATER

Objective To explain the methods and results of filtration in the treatment of water.

Suggested Prerequisites
9.1

Approximate Time
20 hours

9.5.1 To demonstrate an understanding of the design of various types of filter systems in the treatment of water.

9.5.2 To explain how the various types of filter media are built and operate.

9.5.3 To demonstrate an understanding of the factors that are evident in filter systems such as its limitations, microstraining techniques, climatic considerations and the various filter media used.

Module 9.6 CHLORINATION TREATMENT OF WATER

Objective To explain the methods and results of chlorination treatment of water.

Suggested Prerequisites
Biology
Chemistry
9.1

Approximate Time
20 hours

9.6.1 To recognize the various chlorine gases and compounds used as disinfectants in water.

9.6.2 To explain the meaning of the following methods of chlorination, hypochlorination, pre, post, and break point chlorination.

Module 9.7 COAGULATION

Objective: To explain the methods and results connected with the use of coagulants in the treatment of water.

Suggested Prerequisites
Chemistry
9.1

Approximate Time
10 hours

9.7.1 To explain the purpose for using coagulants, the type of coagulants used, the process of feeding and control of coagulants.

9.7.2 To explain the design of coagulation and sedimentation basins and the results of coagulation.

Module 9.8 BACTERIALOGICAL CONTROL, SOFTENING AND CLEAR WATER STORAGE

Objective: To explain the following processes in connection with water treatment: Bacterialogical control, softening and clearwater storage.

Suggested Prerequisites
Chemistry
Biology
9.1

Approximate Time
10 hours

9.8.1 To describe the effects of impurities in water, waterborne diseases, disease bacteria, mercury and lead.

9.8.2 To demonstrate an understanding of the following terms important to water analysis:

A. The coliform group.
B. The coliform index.
C. Total bacteria count.
D. Micro-organisms.
E. Macro-organisms.

9.8.3 To describe the methods of control of turbidity, color, pH, minerals, and gases in water purification.

9.8.4 To describe the various softening methods of water and explain the chemical process that takes place in each method.

9.8.5 To perform proper sanitary chemical analysis of water including proper sampling techniques.

9.8.6 To list the precautions necessary for proper clear water storage including inlet design and protection from vandals.

Module 9.9

METHODS OF TREATMENT

Objective: To recognize by examination the various water and waste water treatment processes.

Suggested Prerequisites
Chemistry
9.1

Approximate Time
20 hours

9.9.1 To recognize by examination the following primary water and waste water treatment methods and chambers:

A. Screening
B. Grit removal
C. Comminution
D. Settling
E. Sedimentation

9.9.2 To write a description of the following processes as used in secondary treatment of water and waste water:

A. Aeration
B. Flocculation

C. Filtering
D. Contact stabilization
E. Activated sludge
F. Proprietary
G. Prefabricated systems
H. Lagoons and stabilization ponds
J. Spray irrigation

9.9.3 To write a description of tertiary and other advanced treatment systems including activated carbon, electrodialysis and reverse osmosis.

9.9.4 To describe the need and the methods of adding chlorine and other chemicals directly to water for purification purposes.

9.9.5 To describe the processes of sludge handling including digestion of sludge, drying beds, use of sludge for fertilization, and the process of incineration of dry sludge.

Module 9.10 <u>SELECTION OF TREATMENT METHOD</u>

Objective: To select the proper method of water treatment considering all of the important economic and health aspects.

Suggested Prerequisites
9.9

Approximate Time
20 hours

9.10.1 To determine the receiving stream assimilative capacity using federal, state, and local criteria based on public health aspects.

9.10.2 To prepare a complete analysis of the raw untreated water and treatment required.

9.10.3 To identify climatic and economic factors that are involved in treatment plant selection.

9.10.4 To demonstrate an understanding of the operational considerations involved in selecting treatment methods.

9.10.5 To determine the "real need" for a treatment plant process.

9.10.6 To combine all treatment selection parameters to arrive at most economical and feasible treatment design.

Module 9.11 THE TREATMENT PLANT

Objective: To demonstrate an understanding of the basic elements and the function of each element in the design of a water or liquid waste treatment plant.

Suggested Prerequisites
8.6
8.8
8.9
9.10

Approximate Time
30 hours

9.11.1 To locate and to describe the basic elements of a water or liquid waste treatment plant.

9.11.2 To perform the calculations for the hydraulic gradient, for head losses, and for the various pump needs throughout the treatment plant.

9.11.3 To demonstrate an understanding of the criteria used to determine the sizes of the treatment plant elements and to design the various elements.

9.11.4 To describe the manual operations of a particular type of water treatment plant.

Module 9.12 INDUSTRIAL WASTES

Objective: To determine the proper system for the disposal of the various types of industrial wastes.

Suggested Prerequisites
None

Approximate Time
10 hours

9.12.1 To explain the need for quantitative and qualitative surveys and analysis for proper disposal systems.

9.12.2 To determine the need of separation for the various types of industrial wastes.

9.12.3 To demonstrate the various methods of separating and disposal of industrial wastes.

A. Oil separation
B. Aerators
C. Filters
D. Activated carbon
E. Chemical additives
F. Incinerators
G. Cooling towers

9.12.4 To understand the fundamental methods of industrial metal separation and waste; safety precautions and protection necessary for the removal of toxic and radioactive wastes.

9.12.5 To demonstrate the use of surcharges of earth material to cover or bury certain types of industrial waste.

Module 9.13 RULES, REGULATIONS AND SAFETY

Objective: To demonstrate an understanding of the Federal, State, and Local laws and regulations concerning design and safety in the disposal of industrial wastes.

Suggested Prerequisites
None

Approximate Time
10 hours

9.13.1 To demonstrate an understanding of the federal, state, and local laws regulating industrial waste disposal.

9.13.2 To demonstrate an understanding of the federal and state criteria for design of industrial waste disposal plants.

9.13.3 To demonstrate the proper procedure for completing the forms required by the Federal Refuse Act of 1899 and the State Clean Streams Act.

9.13.4 To demonstrate a practical knowledge of safety precautions regarding employees, visitors and trespassers on or about plant sites, reservoirs, and manholes.

Module 9.14 PREVENTATIVE MAINTENANCE

Objective: To demonstrate an understanding of the standby power units, periodic preventative maintenance and cleaning requirements to maintain a trouble free plant operation.

Suggested Prerequisites
None

Approximate Time
10 hours

9.14.1 To understand the need for, and the availability in case of emergency or breakdown, of stand-by equipment, power, chlorination, tank storage and pumping units for any type of treatment plant.

9.14.2 To obtain a basic knowledge of treatment plant maintenance operations, collection, and distribution systems maintenance. To understand the use of T.V. monitoring of pressure and volumes to determine leakage.

9.14.3 To determine and perform the cleaning requirements for plant and lines systems, and to perform the routine systems inspection and maintenance required for a continuous, safe, and economic operation.

Unit 10

Module 10.1 SOURCES, COMPOSITION, AND DISPOSAL OF SOLID WASTES

Objective: To list the various sources, composition, and disposal of present day solid wastes.

Suggested Prerequisites
None

Approximate Time
20 hours

10.1.1 To write the sources of domestic, commercial, industrial, and agricultural solid wastes.

10.1.2 To list the compositions of the various types of solid waste.

10.1.3 To demonstrate an understanding of the present day methods of solid waste disposal, and the need for modification in the near future.

Module 10.2 ANALYSIS OF SOLID DISPOSAL METHODS

Objective: To analyze the various processes involved in solid waste disposal.

Suggested Prerequisites
2.3

Approximate Time
10 hours

10.2.1 To demonstrate the need for a central solid waste collection agency.

10.2.2 To locate, select, and design a solid waste storage area.

10.2.3 To determine the need and design a feasible and economical transportation system for solid waste collection and disposal.

10.2.4 To demonstrate an understanding of the following methods of solid waste disposal:

A. Land disposal
B. Incineration

C. Composting
D. Ocean disposal
E. Scrap Processing
F. High density compaction

10.2.5 To determine the most feasible and economical solution to a given source of solid waste.

Module 10.3 GEOLOGICAL ASPECTS OF SANITARY LANDFILL SELECTION

Objective To obtain an understanding of the geological requirements for selection of a sanitary landfill.

Suggested Prerequisites
2.3

Approximate Time
10 hours

10.3.1 To demonstrate an understanding of the soil, geologic, and hydrogeologic aspects of landfill selection including the effects of leachate on ground and surface water quality.

10.3.2 To use aerial photography and mapping to determine adjacent land use.

Module 10.4 ENGINEERING ASPECTS OF SANITARY LANDFILL SELECTION

Objective To demonstrate an understanding of the engineering considerations in the selection of a sanitary landfill location.

Suggested Prerequisites
2.4
13.5

Approximate Time
30 hours

10.4.1 To determine life expectancy of the site based on estimated daily sanitary fill volumes.

10.4.2 To determine the availibility of adequate and suitable cover material.

10.4.3 To select a suitable cell and lift design.

10.4.4 To determine the allowable and practical sequence of lifts and cover material usage.

10.4.5 To analyze the final slope sequence and to design slope and surface contours to properly drain landfill site at all times.

10.4.6 To provide proper surface drainage devices.

10.4.7 To provide for collection, containment and treatment of leachate.

10.4.8 To set up adequate ground water monitoring points.

10.4.9 To determine volume and weight measuring facilities required.

10.4.10 To set up a revegetation program.

Unit 11

Module 11.1 THE AIR POLLUTION PROBLEM-HISTORY

Objective: To define the air pollution problem; the characteristics of the pollutants; the concentrations of the pollutants, as compared to standard conditions; and to discuss critical pollution episodes of the past.

Suggested Prerequisites
Chemistry
3.1
3.2
2.1

Approximate Time
30 hours

11.1.1 To demonstrate an understanding of the definition of air pollution including the public health aspects, safe level of emission determination, and relationship to air quality standards.

11.1.2 To demonstrate an understanding of the characteristics of air pollutants including man-made and natural pollution, airborne particulates such as smoke, fog and dust, gases and vapors, and radioactive fallout.

11.1.3 To measure the concentrations of pollutants such as smoke density, suspended particulates, dustfall, gases, and radioactive materials compared to standard conditions of pressure, temperature and moisture content.

11.1.4 To analyze and examine the problem of air pollution as it has developed since the thirteenth century when smoke was first introduced as an air pollution problem. To emphasize the major air pollution crises such as Meuse Valley of 1930; Donora, Penna. of 1948; London of 1952; New York of 1963, 1966; and to list the similarities and dissimilarities of these crises.

Module 11.2 AIR POLLUTANTS AND THEIR EFFECTS--SOURCES AND LEVELS

Objective: To describe the effects of air pollution in the atmosphere, vegetation, materials, animals and effects on human health. To list the various sources of air pollution and the levels produced by these sources.

Suggested Prerequisites
Earth Science/General Science
Chemistry
2.1, 3.1, 3.2

Approximate Time
40 hours

11.2.1 To describe how visibility is affected by particulates and nitrogen dioxide in the atmosphere.

11.2.2 To describe how the climate is affected by carbon dioxide, particulates and vapor trails in the atmosphere.

11.2.3 To describe how vegetation is affected by sulfur dioxide, fluorine compounds, smog, and oxidizing compounds.

11.2.4 To describe how materials are affected by air pollution in the form of corrosion, erosion, coloring, and life expectancy of the materials.

11.2.5 To describe how air pollution affects domestic pets, poultry, large farm animals, species extermination, and animal health.

11.2.6 To demonstrate an awareness of the mortality involved with such air pollution episodes as Meuse Valley, Belgium; Donora, Penna.; London, England; Los Angeles, Cal.; New York City.

11.2.7 To describe how air pollutants such as sulfur dioxide, sulfur trioxide, ozone, particulates, carbon monoxide, beryllium fluoride, aeroallergens, Carcinogens, and insecticides affect the health of humans.

11.2.8 To determine the sources and levels of air pollution brought about by the use of the internal combustion engine in the fields of land, sea and air transportation.

11.2.9 To determine the sources and levels of air pollution brought about by the use of stationary burners, using gas, oil, or solid fuel types with the major pollutants being sulfur oxides, nitrogen oxides, and particulates.

11.2.10 To determine the sources and levels of air pollution in the industrial processes of petroleum refining, nonmetallic mineral products, metallurgical processes, inorganic chemical processes, pulp and paper industry, and food and feed industry in the pollutant form of carbon monoxide, particulates, sulfur oxides and hydrocarbons.

11.2.11 To determine the sources and levels of air pollution caused by the incineration of solid wastes with the major pollutants being carbon monoxide, hydrocarbons, and particulates.

11.2.12 To determine the levels of air pollution brought about by such miscellaneous sources as forest fires, agricultural burning, coal waste fires, and pollen producing vegetation; the major pollutants being carbon oxides, sulfur oxides, nitrogen oxides, particulates, and hydrocarbons.

Module 11.3 THE ROLE OF METEOROLOGY IN AIR POLLUTION

Objective: To investigate the effects of winds, temperature, precipitation, and normal air currents on air pollution.

Suggested Prerequisites
Earth Science/General Science

Approximate Time
30 hours

11.3.1 To investigate and understand the dilution of pollutants brought about by general wind currents, wind roses, local winds, sea breezes, and wind effects caused by topography.

11.3.2 To investigate the effects of mechanical and thermal turbulence upon the dilution of air pollutants.

11.3.3 To demonstrate an understanding of the following lapse rates and their effects on air pollution.

1. adiabatac
2. unstable
3. stable
4. inversions

11.3.4 To describe the natural removal of air pollutants by gravitational settling, precipitation, and surface impaction.

11.3.5 Investigate the basic concepts of meteorology.

Module 11.4 AIR POLLUTION SAMPLING AND ANALYSIS

Objective: To determine the need for sampling of atmospheric pollution, to describe the various means of collecting air samples and to describe the devices used to analyze the air samples.

Suggested Prerequisites
Chemistry
Biology
General Science

Approximate Time
30 hours

11.4.1 To understand the need of air sampling to meet occupational health standards, to determine ambient concentrations of pollutants, to locate the origin of pollutants, and to determine the efficiency of the pollution control equipment.

11.4.2 To determine the proper location for taking the air samples such as sampling stack emissions, community air sampling, and auto emissions.

11.4.3 To describe the visual methods of sampling and analysis of particulate matter including the Ringelmann charts, photometric devices, and nephelometer.

11.4.4 To describe the use of settling chambers, petri dishes, microscopic slides, and fallout containers in the sampling and analysis of particulates.

11.4.5 To describe the use of the following filtration devices in the collection and analysis of particulates:

1. Sampling trains
2. Membrane filters
3. Hi-vol. samplers
4. Tape samplers

11.4.6 To describe the methods of static sampling of gaseous pollutants with lead dioxide candles, sulfation plates, lined filter papers and fabric panels.

11.4.7 To demonstrate the use of sampling trains to sample gaseous pollutants.

11.4.8 To demonstrate the use of automatic devices for sampling gaseous pollutants.

11.4.9 To demonstrate the method of analyzing gaseous pollutants by observing the effects upon vegetation.

11.4.10 To demonstrate the method of grab sampling of gaseous pollutants.

Module 11.5 PREVENTION AND CONTROL OF AIR POLLUTION

Objective: To describe how air pollution can be prevented by selective plant locations, zoning ordinances, by process changes, by use of control equipment and meteorological control.

Suggested Prerequisites
11.3
General Science

Approximate Time
20 hours

11.5.1 To describe how proper selection of site locations can be used in the prevention and control of air pollution.

11.5.2 To describe how air pollution can be controlled or eliminated by instituting process changes in industry, transportation, and electric power production.

11.5.3 To describe how air pollution can be controlled or eliminated by application of the following control equipment:

a. gravity settling chambers
b. inertial separators
c. cyclonic separators
d. filters
e. electrostatic precipitators
f. scrubbers
g. incinerators

11.5.4 To describe how certain meteorological conditions can be controlled by use of tall stacks and use of optimum dispersion conditions.

Module 11.6 AIR QUALITY CRITERIA AND STANDARDS

Objective: To write required standards and criteria to produce and maintain the various levels of desirable air quality.

Suggested Prerequisites
Biology
Chemistry

Approximate Time
10 hours

11.6.1 To list the air quality criteria that product biological effects upon air environment and to describe these effects.

11.6.2 To list the air quality criteria that produce physical effects upon our environment and to describe these effects.

11.6.3 To describe how air quality standards are established by (a) using air quality criteria (b) comparing with another community standards (c) using prior levels of air quality (d) establishing air quality regions.

11.6.4 To determine the emission standards for a given area based on the air quality standards for that area using process, fuel, and equipment information.

11.6.5 To establish standards for a given area governing location of buffer zones, determining stack heights, usage of various types of equipment, types of fuel used, and to list the tests to be performed to satisfy these standard requirements.

Module 11.7 AIR POLLUTION CONTROL PROGRAMS

Objective To list the objectives of air pollution control programs including the various local, state, and federal programs.

Suggested Prerequisites
None

Approximate Time
10 hours

11.7.1 To explain the objectives of an air pollution control program concerning health and welfare of man, plant and animal life, preventing damages to physical property, providing visibility for safe transportation, and generally, to ensure an esthetically acceptable and enjoyable environment.

11.7.2 To explain the local, state, interstate, and federal governmental air pollution control programs.

11.7.3 To define a typical air pollution problem including emission inventories, air quality measurements, monitoring air pollution effects, visual detection and source sampling.

11.7.4 To describe the methods of correcting local air pollution problems such as preparation of local air quality standards, preparation of local emission control regulations, enforcement of laws and regulations, and preparation of a local air pollution alert system.

Module 11.8 AIR POLLUTION IN LOCAL INDUSTRIES

Objective To describe the air pollution problems in the steel, electric, and coal industries and to describe the control methods being used by each industry.

Suggested Prerequisites
None

Approximate Time
10 hours

11.8.1 To demonstrate an understanding of the basic sources of air pollution in the steel industry such as fluorides, organic carcinogens, particulates and the sulfur compounds.

11.8.2 To demonstrate an understanding of the basic air pollution control methods being used by the steel industry today such as electrostatic precipitators, wet scrubbers, and dispersion by the use of tall stacks.

11.8.3 To demonstrate an understanding of the basic sources of air pollution in the electric generating industry such as nitrogen oxides, organic carcinogens, particulates, and the sulfur oxides.

11.8.4 To demonstrate an understanding of the air pollution control methods being used by the local modern high powered generating stations including electrostatic precipitators and the use of extremely high stacks for the dispersion of the pollutants.

11.8.5 To demonstrate an understanding of the air pollution problems that exist underground in the coal mining industry and also the air pollution problems that exist above ground at the coal cleaning plants.

11.8.6 To demonstrate an understanding of the air pollution control methods employed by the local coal mining industry.

Module 11.9 AUTO EXHAUST PRODUCTS

Objective: To list and describe the harmful auto exhaust products and to describe the pollution control methods for each product.

Suggested Prerequisites
Chemistry

Approximate Time
20 hours

11.9.1 To list and describe the toxic effect of the exhaust product boron and to explain the control measures of reducing the use of boron additives in gasoline.

11.9.2 To list and describe the very dangerous poisonous gas, carbon monoxide, and to describe the various methods being attempted to provide a more complete combustion of fuels to change CO to CO_2.

11.9.3 To list and describe the sources and causes of toxic hydrocarbon emissions from gasoline and deisel engines, and the method of control of these emissions through use of factory installed devices and other means to insure complete combustion or consumption of these emissions.

11.9.4 To list and describe the sources of lead emissions from gasoline engines and from leaded fuels and to identify the methods of control or eliminations of this poisonous air pollutant.

11.9.5 To list the nitrogen oxide pollutants, to describe their harmful effects and to discuss the methods of control of this type of exhaust emissions.

11.9.6 To list the causes of organic carcinogens pollutants, to describe their harmful effects and to discuss the methods of control or elimination of this type of exhaust emission.

11.9.7 To list the types and causes of air pollution by particulates from auto exhaust emissions, to describe their harmful effects, and to discuss the methods of reduction and control.

Unit 12

Module 12.1 CORROSION PROPERTIES AND EFFECTS

Objective: To describe the properties and effects of underground corrosion, atmospheric corrosion, seawater corrosion, changes in temperatures and pressure corrosions, and chemical action corrosion.

Suggested Prerequisites
Chemistry
12.2

Approximate Time
20 hours

12.1.1 To describe the properties of underground corrosion and the metals affected by underground corrosion.

12.1.2 To describe the damage done to underground pipe lines, cables, and steel structures by the action of corrosion.

12.1.3 To describe the properties of corrosion in the atmosphere and the effects on paints, buildings, roofs, etc.

12.1.4 To describe the properties of corrosion in sea water and the effect on shipping, pipe lines, cables, and underwater structures.

12.1.5 To describe the properties of corrosion of metals in high temperatures and in high pressures and the effects on furnace walls, pressure pipes, steam pipes, electrical, and heat conductors.

12.1.6 To describe the properties of corrosion on metals when acted on by acidic and basic chemical solutions and fumes.

12.1.7 To describe the effects of chemical corrosion such as the action of acids, bases, and oxidation.

12.1.8 To list, describe and explain some of the many common examples of corrosion in our everyday life.

Module 12.2 **CAUSES OF CORROSION**

Objective: To describe the causes of corrosion.

Suggested Prerequisites
Chemistry

Approximate Time
20 hours

12.2.1 To describe the process of electrolysis more commonly known as galvanic action and the relationship to the electromotive series.

12.2.2 To describe the function of the electrolyte in causing corrosion and to list examples of electrolytes in underground, atmospheric and underwater corrosion.

12.2.3 To describe how metal flows from the anode to the cathode in the form of electric current and the resulting damage to the anode.

12.2.4 To describe how moisture in the air, and in the ground, causes corrosion, and the resultant effects.

12.2.5 To describe how chemicals such as acids and bases and oxidations cause corrosion and the resultant effects of these chemicals on the corrosion process.

12.2.6 To explain how high temperature and pressure accelerate corrosion and the resultant effect on metal containers.

12.2.7 To explain how "stray currents" cause corrosion and to list the sources of stray comments.

12.2.8 Demonstrate and explain stress corrosion and its relationship to metal failure.

Module 12.3 **PROTECTING AGAINST CORROSION**

Objective: To explain and describe the various methods of prevention and protection against corrosion of metals.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

12.3.1 To explain the function of the cathode and anode in the flow of current thru batteries and during the process of corrosion.

12.3.2 To explain the corrosion prevention process called "Cathodic Protection."

12.3.3 To list the various types of metal, plastic, oil, paint, and tar coatings that are used to protect against corrosion and to explain under what conditions each type of coating is used.

12.3.4 To explain the term "Holiday", the problems they cause, and how they are detected and eliminated in the field of corrosion.

12.3.5 To discuss the use of chemicals and their compounds to control oxidation corrosion, acid and alkaline corrosion by setting up opposing chemical reactions.

12.3.6 To explain the use of "impressed currents" to reverse the flow of current and change the anode to a cathode thus stopping the corrosion process of the metal object or structure.

Module 12.4 AIR POLLUTION AND CORROSION

Objective To demonstrate the relationship between air pollution and corrosion and how to protect metal objects from corrosion in polluted areas.

Suggested Prerequisites
Chemistry

Approximate Time
20 hours

12.4.1 To explain the chemical process of corroding acids forming from the oxides of nitrogen and sulfur in polluted air and their harmful effects on paints, metal buildings, and structures.

12.4.2 To explain how particulates of fly ash and cinders carried in air from stack emissions settle around and on metal objects reacting with water to cause corrosion.

12.4.3 To explain the harmful corrosion effects of the compounds formed from nitrogen and carbon dioxide when mixed with a pollutant type reagent.

12.4.4 To explain the corrosion effects of the many types of strong chemical fumes released into the atmosphere by the chemical industry.

12.4.5 To describe the use of special coatings of paint, oils and asphalt mixtures to prevent corrosion resulting from air pollution.

Module 12.5 WATER POLLUTION AND CORROSION

Objective: To demonstrate the relationship between water pollution and corrosion and how to protect metal objects which are exposed to polluted water.

Suggested Prerequisites
Chemistry
10.12

Approximate Time
10 hours

12.5.1 To explain the necessity of using treated water to prevent corrosion in electric generating stations when steam is used to operate the turbines and when water is used to cool the turbines.

12.5.2 To explain how industrial wastes deposited in water can set up a corrosion process to affect underwater metal structures, pipe lines, and cables.

12.5.3 To explain the need to neutralize acid mine drainage whenever it comes in contact with a metal object that is not protected against corrosion.

12.5.4 To explain why it is necessary to protect ships, cables, metal piers and structures from the polluting salts of sea water.

Unit 13

Module 13.1 SOIL EROSION

Objective: To demonstrate how man is causing mass erosion by removing or killing trees and vegetation by increasing rainfall runoff thru paving and by covering valuable fertile land with industrial waste piles.

Suggested Prerequisites
Earth Science/General Science
Biology

Approximate Time
10 hours

13.1.1 Investigate the significant losses of agricultural soil, water, and woodland resources in relation to the improvement of man's total environment.

13.1.2 Demonstrate methods used to prevent soil erosion in highway and community planning projects where pavement replaces natural ground cover.

13.1.3 Discuss the function of the Soil Conservation Service.

13.1.4 To demonstrate the process of killing vegetation and trees in the areas covered or affected by waste pile rain corrosion.

Module 13.2 ECOLOGICAL EFFECTS OF MINING

Objective: To demonstrate how man is destroying drinking water sources, ruining the topography, causing subsidence, and polluting our land and streams by deep mining and strip mining.

Suggested Prerequisites
Earth Science/General Science

Approximate Time
20 hours

13.2.1 Demonstrate the effects of mining on fresh water sources of supply.

13.2.2 Describe the ecological effects of culm heaps and strip mine spoil piles.

13.2.3 Debate the long range effects of deep mine and surface mine operations.

13.2.4 Discuss procedures for land reclamation in mining areas.

Module 13.3 PESTICIDES

Objective: To demonstrate how pesticides, while being used to help man, can destroy man as well as destroy the whole balance of nature.

Suggested Prerequisites
Chemistry

Approximate Time
10 hours

13.3.1 Demonstrate the safety precautions necessary for the efficient use of pesticides.

13.3.2 Discuss the long range effects of pesticides on the environment.

13.3.3 Demonstrate the effects of spraying pesticides on air quality.

13.3.4 Describe the effect of pesticides on food chains.

13.3.5 To demonstrate how generally the use of certain pesticides can upset permanently the whole balance of nature.

Module 13.4 GAS STORAGE/ENVIRONMENTAL & ECONOMICAL IMPACT

Objective: To demonstrate how existing dry wells are being used for gas storage, the danger of leakage, and the possibilities of potential serious explosions.

Suggested Prerequisites
Earth Science/General Science

Approximate Time
10 hours

13.4.1 To demonstrate how existing dry wells are being utilized for gas storage in the State of Pennsylvania.

13.4.2 To point out the dangers of gas leakage from the storage areas and the potential danger of gas explosions.

13.4.3 To demonstrate how gas leakage from these wells can pollute underground streams and water wells.

13.4.4 To demonstrate the dangers of drilling into these storage areas while drilling for water, causing potential gas leaks.

Module 13.5 WATER TABLES, WELLS AND SEPTIC TANKS

Objective: To demonstrate how water tables are being lowered by excessive drilling and increased rain runoff; how wells are polluting the sub-soil and underground streams; and how septic tanks are polluting the soil and ground water.

Suggested Prerequisites
Earth Science/General Science

Approximate Time
20 hours

13.5.1 To demonstrate how water tables of the earth are being constantly lowered by the continuous draw-down of the many residential and industrial water wells.

13.5.2 To demonstrate the lowering of the water table, decreasing the absorption capabilities of the environment by replacing vegetation with blacktop or barren land.

13.5.3 To demonstrate the dangers of each residence drilling individual water wells and the effect it can have on water tables, underground streams, and the underground pollution of water.

13.5.4 To demonstrate how solid, water, and air pollution can penetrate into the earth through abandoned and improperly sealed water wells.

13.5.5 To demonstrate how mass usage of septic tanks can pollute the ground water, produce obnoxious odors, and cause spread of disease germs.

13.5.6 To demonstrate how the use of septic tanks can destroy the soil qualities in the leachate area.

Module 13.6 SOIL DRAINAGE

Objective To demonstrate how proper soil drainage is necessary to preserve the fertility of the soil and to conserve the land for agriculture.

Suggested Prerequisites
8.0

Approximate Time
10 hours

13.6.1 To demonstrate how soil is being eroded away because of excessive rain runoff and lack of vegetation to bind the soil together.

13.6.2 To demonstrate how soil is losing the ability to absorb water because the added impurities have decreased the porosity of the soil.

13.6.3 To demonstrate the necessity of providing proper drainage of the soil to prevent forming of swamps, destroying of farm land and the spread of mosquitoes and other insects.

Appendix I

List of Related Occupations

OCCUPATION	D.O.T. CODE NUMBER
ELECTROLYSIS-AND-CORROSION CONTROL ENGINEER	003.187-030
ENVIRONMENTAL RESEARCH TECHNICIAN	003.281-026
LABORATORY ASSISTANT, METALLURGICAL	011.281-010
AIR ANALYST	012.281-010
SMOKE TESTER	012.281-014
GEODETIC COMPUTER	018.188-010
INSTRUMENT MAN	018.188-014
SURVEYOR	018.188-026
SURVEYOR, GEODETIC	018.188-034
MARINE SURVEYOR	018.188-038
MINE SURVEYOR	018.188-042
TRANSIT MAN	018.188-050
RODMAN	018.587-010
CHAINMAN	018.687-010
CHEMICAL-LABORATORY TECHNICIAN	022.281-014
CHEMIST, WATER PURIFICATION	022.281-018
LABORATORY TESTER I	029.281-010
PURIFICATION OPERATOR I	551.782-030
WASTE-TREATMENT OPERATOR	559.782-234
SAMPLER	559.887-082
WATER-TREATMENT-PLANT OPERATOR	954.782-026
WATER-FILTER CLEANER	954.887-014
SEWAGE-PLANT OPERATOR	955.782-018

Appendix J

List of Laboratory Equipment

Furniture and Supplies

Building and equipping laboratories for teaching Engineering Related Technology is expensive. It was deemed necessary to spread the expense over more than one year. Basic equipment will be purchased and installed now. However, some of the more complex instruments will be purchased and installed at a later date.

Four laboratory areas are utilized in this course. The first is essentially a standard wet-chemistry analytical laboratory. The second is a biology related laboratory. The third laboratory is a larger unit operations laboratory having more free working area for performing experiments involving larger pieces of equipment and having some permanently installed working stations, fume hoods and cabinets. The fourth laboratory is a water laboratory used for fluid mechanics and basic raw material analyses.

A. Equipment

Automatic tape air sampler with recorder ------------------ 1 each

High volume air sampler ---------------------------------- 1 each

SO_2 and dustfall monitoring station (with stand) -------------- 1each

Flame emission, atomic absorption spectrophotometer ------ 1 each

Six unit electric micro Kjeldahl digestion rack with 200 watt heaters--- 1 each

Dual scale oxygen analyzer ------------------------------- 1 each

Precision measurement wet test gas meter ------------------ 1 each

BOD manometric apparatus ------------------------------- 1 each

Water pollution test kit to measure 22 water quality parameters with instructions for performing 100 different tests-1 each

Gas chromatograph-basic dual thermal conductivity detector instrument with strip chart recorder-single pen ------------- 1 each

Chromatography kit-electrophoresis ----------------------- 1 each

Chromatography kit-thin layer ---------------------------- 1 each

Automatic siphon, stainless steel pipet washer ------------- 1 each

Expanded scale pH meter ---------------------------------- 1 each

Six multiple spindle stirrers ------------------------------1 each

Variable speed-double range magnetic stirrer --------------- 1 each

Karl Fischer titration units--------------------------------- 1 each

Spectrophotometer with red sensitive phototube and filter----- 1 each

2600 to 9100 r.p.m. centrifuge ---------------------------- 1 each

Six place centrifuge head for metal shields------------------ 1 each

50 ml. metal shields for centrifuge head with rubber cushions- 6 each

Angled 12 x 15 ml. centrifuge head ------------------------ 1 each

15 ml. centrifuge shields ----------------------------------12 each

Upright manometer gauge and metal case with graduated sliding scale -- 1 each

11.5 c.f. glove box with totally closed work chamber 35" x 25 1/2" x 26 1/2" inside measurements --------------------- 1 each

14 x 14 magnifiers with folding metal case ------------------ 6 each

Bacteria counting glass magnifiers with double convex lens 3 1/2 x magnification --------------------------------------- 6 each

Magnifier illuminators with 5" lens ------------------------ 3 each

Scaled down model, electrostatic precipitator, smoke generator and flowmeter included--------------------------- 1 each

Turbidimeter with turbidity charts included ----------------- 1 each

Anaerobic culture jar with B.B.L. gas pak -------------------1 each

Electrically heated portable autoclave ---------------------- 1 each

Model 83, low temperature bacteriological incubator
(for B.O.D.) -- 1 each

Water jacketed, CO_2 bacteriological incubator -------------- 1 each

Quebec Bacteria Colony Counter ----------------------------- 1 each

Electric (dry heat) sterilizer ------------------------------ 1 each

120g, capacity balance -------------------------------------- 1 each

Dial reading chainomatic balance, 200 grams on each pan,
1/20 mg. sensitivity -- 1 each

Solution balance, 20 kg. capacity and 1 gram sensitivity ------ 1 each

Stainless steel triple beam balance, 1610 grams capacity,
..05 gram sensitivity -- 1 each

Class S balance weights ------------------------------------- 1 set

Balance with 310 gram capacity, .01 grams sensitivity ------- 2 each

Direct reading, 200 gram capacity analytical balance .01 grams
sensitivity -- 1 each

Binocular microscope with three objectives (10x, 40x, 100x)----1 each

Photobinocular microscope, 1x to 2x zoom, four objectives
4x, 10x, 40x, and 100x, Hi-intensity illuminator in base ------ 1 each

Flat field microscopes, magnification range 100x to 1000x---- 6 each

100 watt microscope illuminators --------------------------- 6 each

Electric muffle furnace with indicating pyrometer and heat
controller --- 1 each

3 cubic foot capacity gravity convection oven ---------------- 1 each

Mechanical convection oven with operating range to 225° C
and dual hydraulic thermostats ------------------------------- 1 each

Portable water still with capacity 1/2 gal./hr. --------------- 1 each

Constant temperature baths with adjustable controls for temperatures to 100° C-- 1 each

Portable air pump for vacuum and pressure----------------- 1 each

Laboratory refrigerator with 2 shelves, 4 c.f. cap.---------- 1 each

Table top balance supports dampers------------------------ 5 each

Hand model centrifuge with speeds up to 2500 r.p.m. with 4 place 15 ml. head-- 1 each

6 1/2" dia. hot plate, nucerite top, maximum temperature 370° C., thermostatically step controlled------------------ 3 each

Stopwatch with 1/10 sec. decimal timer and 10 minute central dial-- 3 each

Split action, 1/5 second Stopwatch-------------------------- 3 each

Stopwatch holder with clip-on mounting plate for securing to bench-- 1 each

Duo-Seal, two-stage air pump------------------------------ 1 each

Pump cart which supports up to 500 lbs.-------------------- 1 each

Electronic calculator with capabilities of memory storage, programming and performing multiple mathematical functions in one operation--- 1 each

Windscope for both direction and velocity of wind. Two wind velocity scales are provided 0-25 M.P.H. and 25-100 M.P.H. - 1 each

Maximum-Minimum thermometer for air temperatures range from -40° to 130° F-------------------------------------- 1 each

Rain gauge for measuring rainfall up to 5.0 inches----------- 1 each

Electrically operated recording barometer for use 0 to 5500 ft. elevation and 7 day recording chart------------------------ 1 each

Complete chemical soil testing kit for 13 different soil tests--- 1 each

Moisture meter for determining soil moisture content---------1 each

Specific gravity balance for liquids and solids reading to 4 decimal places--- 1 each

Precision hydrometer set for specific gravity of liquids------- 1 each

Photomicrographic camera to fit microscope----------------- 1 each

Instructional spectrophotometer with range 400 to 700 mu.---- 1 each

Glass float type calibrated flowmeter kit------------------- 1 each

Geiger counter suited for class demonstrations-------------- 1 each

"Super Sniffer" Geiger counter------------------------------ 1 each

Battery powered portable CO indicator instrument to measure CO in atmosphere-- 1 each

Water purity meter for conductometric measurement or monitoring of electrolyte impurities in distilled or deionized water--- 1 each

Combination vacuum oven, drying oven and dessicator-------- 1 each

Dessicator with ground glass cover------------------------- 1 each

Gas burner-- 12 each

B. Furniture

Bench Assembly 60" long x 31" depth with chemical resistant work top and 4 storage drawer unit, double cupboard with adjustable shelf and 2 drawer unit, end filler panels, and cove molding-- 1 each

Bench Assembly 95 5/8" long x 31" depth with chemical resistant work top and 4 storage drawer unit, single cupboard unit with roll out tray shelf, 2 drawer unit with knee space for sitting, end filler panels and cove molding--------------- 5 each

Island Bench-Sink Assembly 13' 8 5/8" long x 36" high x 4'7" width with chemical resistant work top. 4 8 storage drawer units 2 end sink units w/cupboard, 2 single cupboards, 2 cup sinks, adjustable shelf, electrical outlets, hot and cold water faucets and gas outlets, p-traps, end filler panels and cove molding--- 2 each

Table Assembly 94 5/16" long x 24" wide x 30" high with composition work top with single cabinet and storage drawer unit, and 2 seat positions w/single storage drawer----------- 2 each

Table Assembly 94 5/16" long x 24" wide x 30" high with composition work top and single cabinet and storage drawer unit, and 2 seat positions w/single storage drawer----------- 2 each

C. Supplies

Assorted Graduated Cylinders

Assorted Beakers

Assorted Beaker Caps and Covers

Assorted Flasks

Assorted Funnels

Assorted Burets

Buret Tips

Assorted Pipets

Pipet Filler

Thermometers - 20 to +110° C

Assorted Test Tubes

Alkacid Tester

Centrifuge Tubes

Assorted Alkacid Short Range Dispensers

Alkacid Full Range pH Test Kit

Assorted Litmus Test Paper

Assorted Filter Paper

Assorted Rubber Gloves

Goggles, Student

Stopcock Grease

Scoopula

Scoopula Handle

Multi-Purpose Towels

Laboratory Towels

Washing Bottles

Aprons

Assorted Rubber Stoppers

Assorted Rubber Tubing

Assorted Polyethylene Tubing

Glass Rods

Spatulas

Evaporating Dishes

Assorted Test Tube Brushes

D. Chemicals

Hydrochloric Acid	Nitric Acid
Sulfuric Acid	Acetic Acid .
Ammonium Hydroxide	Phosphoric Acid
Sodium Acetate	Sodium Bicarbonate
Sodium Bisulfate	Sodium Borate
Sodium Carbonate	Sodium Chloride
Sodium Chromate	Sodium Citrate
Sodium Iodide	Sodium Nitrate
Sodium Oxalate	Ammonium Bicarbonate
Ammonium Bifluride	Ammonium Carbonate
Ammonium Chloride	Ammonium Oxalate
Ammonium Sulfide	Zinc Acetate
Zinc Sulfate	Lead Nitrate
Magnesium Nitrate	Sodium Sulfate
Sodium Sulfide	Sodium Thiosulfate
Sodium Phosphate	Sodium Silicate
Potassium Carbonate	Potassium Chlorate
Potassium Chromate	Potassium Ferricyanide
Potassium Ferrocyanide	Potassium Iodate
Potassium Iodide	Potassium Nitrate
Potassium Chloride	Potassium Acetate
Potassium Bitartrate	Potassium Bromice
Potassium Citrate	Barüim Chloride

Ferric Chloride

Ferric Chloride Solution

Magnesium Sulfate Crystal

Potassium Sulfate

Ferric Sulfate

Magnesium Chloride

Sodium Hydroxide, pellets

Ferrous Ammonium Sulfate

Iodine

Lead Acetate

Chromium Nitrate

Potassium Nitrate

Nickel Carbonate

Hydrochloric Acid 1 N

Iodine Solution

Buffer Solution, pH 1.00

Buffer Solution, pH 7.00

Sulfa Orange

Methyl Violet

Thymol Blue

Methyl Red

Bromo Cresol Purple

Bromo thymol Blue

Phenolphthalein

Calcium Chloride

Magnesium Sulfate Solution

Potassium Dichromate

Chromium Sulfate

Ferrous Sulfide

Magnesium Sulfate

Potassium Hydroxide, pellets

Ferrous Sulfate

Cobalt Nitrate

Lactic Acid

Citric Acid

Strontium Nitrate

Sodium Thiosulfate, 1 N

Sodium Hydroxide 1 N

Silver Nitrate 1 N

Buffer Solution, pH 4.00

Buffer Solution, pH 11.00

Cresol Red

Metacresol Purple

Bromophenol Blue

Methyl Purple

Chlorophenol Red

Phenol Red

o-Cresolphthalein

Alizarin Yellow GG	Indigo Carmine
Malachite Green	Crystal Violet
8-Hydroxyquinoline	Methyl Alcohol
Ethyl Alcohol (Absolute)	Butyl Alcohol
Isopropyl Alcohol	Hydrogen Peroxide
n -Propyl Alcohol	Acetic Anhydride
Benzaldehyde	Mercuric Chloride
Mercuric Oxide	Formaldahyde
Ferric Oxide	Glycerin
Lithium Chloride	Boiling Stones
Starch (soluble)	Stearic Acid
Naphthalene	Pyrogallic Acid
Oxalic Acid	Charcoal (animal)
Charcoal (coconut)	Cotton Seed Oil
Kerosene	Cornstarch
Castile Soap	Parafin
Sand (sea)	Kaolin
Lead Stick	Zinc Metal (stick)
Zinc Metal (granular)	Lead Metal (granular)
Zinc Stearate	Magnesium Metal (Ribbon)
Phosphorous Red	Phosphorous (Yellow)
Aluminum Wire	Sodium

Sulfur

Iron Wire

Copper Wire

Tin Metal (granular)

Mercury

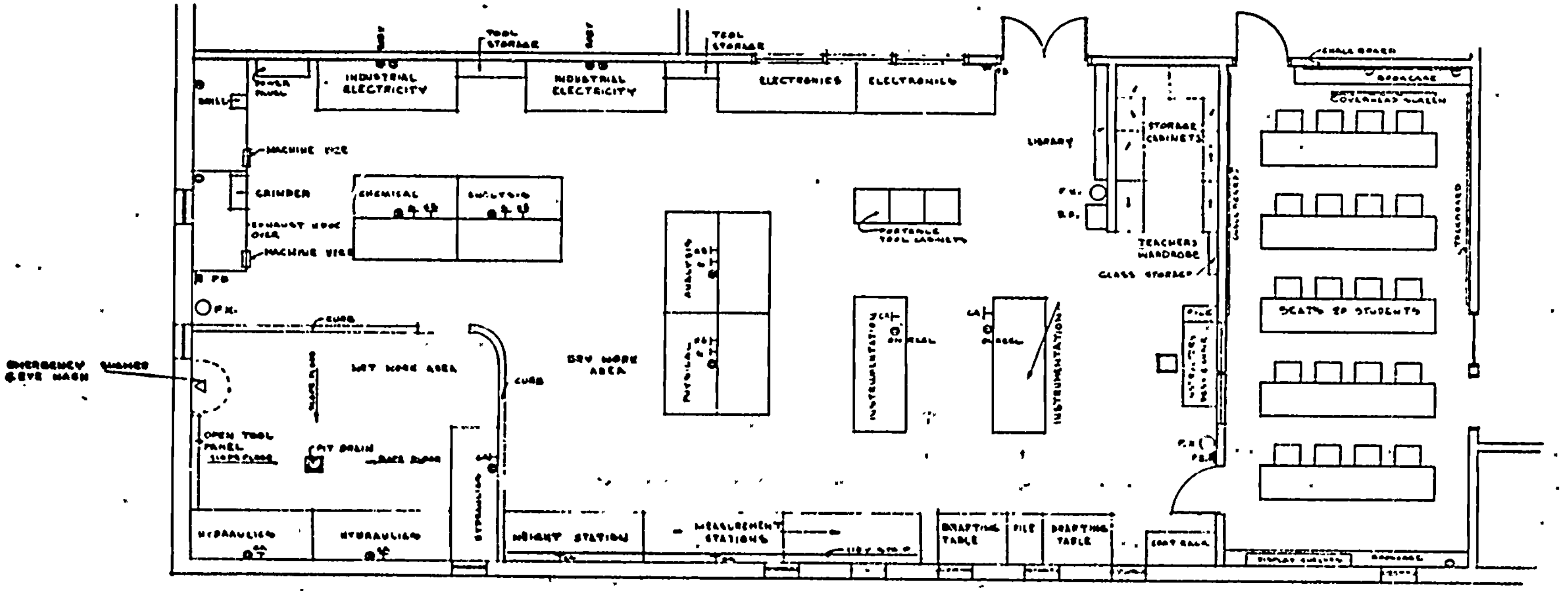
Coliform Kits

Appendix K

Floor Plan of

Instructional Area and

Laboratory



ENGINEERING RELATED TECHNOLOGY

SCALE: 1/8" = 1'-0"

INSTRUCTIONAL PLANNING

SCALE: 1/8" = 1'-0"

ADMIRAL PEARY AREA VO-TECH SCHOOL

EBENSBURG, CAMBRIA COUNTY, PENNSYLVANIA

L. ROBERT KIMBALL AND ASSOCIATES

ENGINEERS AND ARCHITECTS

EBENSBURG, PENNSYLVANIA

OCTOBER 25, 1970