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ABSTRACT

Designed for use in institutional self-studies and program reviews, these guidelines provide a comprehensive model for chemistry and chemical technology programs in two-year, associate-degree-granting colleges. The eight sections of the guide suggest 90 standards in the areas of: (1) chemistry program mission and periodic program review; (2) organizational structures supporting chemistry programs; (3) financial support and budgetary allocations; (4) the curriculum, covering program development, course scheduling, course prerequisites, the spectrum of introductory chemistry courses, general chemistry for science and engineering majors, preparatory chemistry courses, chemistry transfer programs, chemical technology programs, and chemistry courses for nonscience, allied health, engineering, and other programs and groups; (5) qualifications and working conditions of faculty and supporting staff; (6) academic advising and counseling; (7) articulation with secondary schools, transfer institutions, and industry; and (8) facilities, including lecture rooms, office space, student instructional laboratories, instructional support facilities, and the library. (EJV)

GUIDELINES FOR CHEMISTRY AND CHEMICAL TECHNOLOGY PROGRAMS IN TWO-YEAR COLLEGES

AMERICAN CHEMICAL SOCIETY

SOCIETY COMMITTEE ON EDUCATION

TASK FORCE ON ACS INVOLVEMENT
IN THE TWO-YEAR COLLEGES

American Chemical Society
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Each of the standards in this document is labeled with an "S" followed by a number. This notation enables users of the document to easily locate specific references to areas of interest.

INTRODUCTION

The *Guidelines for Chemistry and Chemical Technology Programs in the Two-Year Colleges*, developed by the American Chemical Society (ACS), provide a comprehensive model for two-year colleges that grant associate degrees and for non-baccalaureate chemical technology programs offered at other institutions. These *Guidelines* allow institutions to review the quality of their chemistry and/or chemical technology programs[1] (see page 20 for footnotes) and related services by serving as

- a guide for institutional self-studies and program reviews,[2]
- a set of standards for program review and evaluation through the College Chemistry Consultants Service,[3] and
- a resource for regional accrediting groups when revising self-study guidelines and conducting visitations for periodic assessment of programs.[4]

Scope and Aims of Guidelines

The *Guidelines* are meant to help faculties provide chemistry students with the best possible education in the fundamental areas of modern chemistry and its relation to other disciplines and to society. To achieve this goal, general curricular goals rather than specific curricular content are defined. Implementing the *Guidelines* can ensure that the chemistry course offerings and programs of an institution

- are consistent with the mission of the institution,
- meet the needs of the diverse backgrounds and abilities of entering students,
- utilize and enhance the strengths of the institution and the community,
- articulate with the chemistry programs at those four-year colleges to which most students transfer (referred to throughout this document as the major transfer institutions),
- are comparable to programs of recognized quality,
- meet local industries' needs for technical personnel, and
- augment the continuing education and other local community chemistry education needs.

Types of Institutions

The *Guidelines* are designed to accommodate all those postsecondary institutions generally referred to as two-year, associate-degree-granting colleges. They attempt to take into account the great diversity of these institutions and their programs, the great heterogeneity of the student body, the diverse curriculum, and other characteristics unique to these institutions. The *Guidelines* describe optimum standards for a comprehensive two-year college chemistry program and for a modern laboratory-oriented chemical technology program. Institutions that do not have a comprehensive mission may find that some of these standards are not applicable to their mission. In such cases, the standards applicable to their mission should be used in the review process. Institutions that have low enrollments may find it difficult to achieve some of these standards. In such cases, the *Guidelines* may help give a direction to future program development and growth.

Use of Guidelines

These *Guidelines* are intended to improve programs rather than to approve or disapprove them.[5] Institutions should carefully consider their rationale for deviation from a standard and provide explanation in a self-study document. External consultants can evaluate these self-study reports to determine if the *Guidelines* are being followed as closely as feasible. Often the consultants can help colleges develop creative solutions to problem areas as well as devise approaches that provide greater compliance with the *Guidelines*.

Areas of Concern

The *Guidelines* are concerned with chemistry transfer courses and programs for science and engineering majors, chemical technology courses and programs, and

other chemistry courses not included above, such as those for allied health occupations and nonscience majors. (Section IV reflects this organization.) The *Guidelines* are also concerned with the quality of the chemistry faculty and its supporting staff, student and counseling services, articulation with other institutions and local industries, and facilities.

Institutions adhering to these *Guidelines*, especially the appropriate articulation standards, should find that science and engineering majors can transfer to most four-year institutions without difficulty; that students completing chemical technology programs can find employment more easily; and that the quality of the chemistry education of all students has been improved.

Sections that follow describe a comprehensive model. The self-study forms that are to be used with these *Guidelines* relate to each of the standards. The standards are to be considered as characteristics of the model; they are marked with a boxed S type of notation and the text is printed in bold type.

Chemical Technology Programs

Chemical technology programs may be organized in a number of ways within the institutional structure. They may be a part of an independent unit usually referred to as a chemistry department or may be part of a larger unit including other technologies and sciences. In rare instances, they may exist outside the aforementioned structures as an independent program. Whatever the institutional placement of chemical technology programs, there are minimal standards to be met, and they are dealt with in the appropriate topical sections of these *Guidelines*. Those institutions that are concerned only with chemical technology programs and not with chemistry courses for other students will find the chemical technology curriculum standards, (S29) through (S39), of particular interest. Additionally, many of the standards in sections III (Financial Support), V (Faculty and Supporting Staff), VI (Students and Counseling), VII (Articulation), and VIII (Facilities) are applicable to chemical technology programs.

I. CHEMISTRY PROGRAM MISSION AND REVIEW

S1 **Chemistry education in the two-year college has a strong institutional commitment to the**

- **preparation of students for careers and upper division work in chemistry, biochemistry, and chemical engineering;**
- **improvement of the chemical literacy of students preparing for other scientific and technical professions and occupations;**
- **increase of the scientific and technological literacy of nonscience students; and**
- **preparation of students for employment as chemical technicians or in chemically related technologies.**

The structure and scope of an institution's program in chemistry are governed by its educational objectives and resources in relation to the needs of all those it serves. The institution must recognize that chemistry is important in many disciplines and technologies and in the intellectual lives of students seeking a liberal education, regardless of their major. The institution's financial commitment to its chemistry program must be sufficient to provide up-to-date instrumentation and supplies and adequate technical and other support services to the faculty. Moreover, institutional policies must allow for efficient, continuous operation of the program.

S2 **The institution has established procedures for periodic evaluation of the effectiveness, level of achievement, and degree of compatibility of its programs with its objectives. When available, discipline-oriented guidelines are used as a part of these program reviews.**

These guidelines, when used for self-study, should seek evidence of the continuing ability of the entire chemistry program to serve its students optimally, recognizing their different needs, interests, and career goals.

II. ORGANIZATIONAL STRUCTURE FOR CHEMISTRY PROGRAMS

S3 **The chemistry programs are administered by the chemistry faculty organized as an independent unit. The faculty has participatory responsibilities in matters such as budget development; chemistry faculty selection, evaluation, promotion; course development; assignment of teaching responsibilities; grading standards; and professional development. The faculty has control of the budget once it is established. At those institutions where chemistry faculty are a part of a larger unit, they have sufficient involvement to function autonomously as set forth above.**

III. FINANCIAL SUPPORT

S4 **The institution has made a financial commitment to the continued operation and stability of a quality chemistry program. Specifically, budgetary allocations provide for**

- **qualified full-time faculty, competitively compensated, of sufficient size and breadth to staff effectively the chemistry courses necessary to serve the educational needs of the students;**
- **qualified part-time faculty, competitively compensated, as needed to provide specific expertise or to accommodate term-to-term fluctuations in enrollments (not to serve as replacements for full-time faculty on anything other than a short-term emergency basis);**
- **trained laboratory technical support staff of sufficient size to provide necessary preparation, demonstration, and stockroom services;**
- **secretarial and clerical help, including student assistants, to aid and lessen the noninstructional work load of the faculty;**
- **media production and assistance as well as library bibliographic assistance necessary to facilitate a high-quality, up-to-date program of instruction;**
- **instructional support services and learning aids compatible with the needs of the instructional program and conveniently accessible to the chemistry faculty and students, such as tutorial services, computer facilities, library resources (including scientific journals and reference materials), audio-visual resources, programmed learning materials, and chemical model sets;**
- **expendable supplies and capital equipment acquisitions required for modern, high-quality laboratory and lecture instruction;**
- **management and disposal of chemical laboratory wastes;[6]**
- **timely equipment maintenance and repair, or replacement;**
- **opportunities for professional growth and development of the faculty, including travel to professional meetings, workshops, seminars, and courses;**
- **sabbatical and professional development leave; and**
- **insurance to cover the faculty for liability while carrying out their professional duties and to replace stolen/damaged equipment and supplies.**

The institution's financial commitment to its chemistry program should be evaluated with respect to these guidelines. In those areas where the budgetary guidelines are not met, institutions should develop long-range plans to improve their financial commitment.

The college board and administration must recognize that laboratory-based science programs, like vocational-technical occupational programs, are more expensive to operate than most other curricula in the two-year colleges.

S5 **If unable to provide financial support as outlined in (S4) from regular funding sources, the institution actively seeks industrial and/or foundation support and strives to convince the governing authorities of the need for differential funding for science laboratory-based programs.**

IV. THE CURRICULUM

A. Program Development

S6 **The curriculum includes the necessary chemistry courses to accommodate varied student and program needs. Each chemistry course is justified in terms of one or more functions of the two-year colleges; namely, transfer, occupational training, general education, remediation, counseling and guidance, and community service.**

In program development, the institution recognizes that, as a result of open-door admissions policies, there is great diversity in the educational background, learning readiness, academic ability, and educational goals of students.[7] It must accept the fact that all students are not prepared to begin chemistry at the same level, and that all programs requiring chemistry do not cover identical topics. Using these *Guidelines* to evaluate a program, the institution should consider the size of the student body and the diversity of the students' educational backgrounds in order to establish the structure of the chemistry curriculum and the presentation of subject matter. In this curriculum section, chemistry curricular areas are outlined for the following three groups of students: science and engineering majors, chemical technology majors, and other majors. The latter group includes, among others, students in allied health occupations, engineering technologies, and liberal arts. Additionally, the number of underprepared and remedial students makes it necessary for many institutions to include preparatory or developmental chemistry courses to prepare these students for the college-level courses.

Typically, comprehensive two-year colleges include one sequence of chemistry courses for chemistry, biochemistry, and chemical engineering majors. This sequence also satisfies the needs of other science majors (e.g., physics, biology, and geology), other disciplines of engineering, pre-professional health science majors (e.g., pre-medicine, pre-dentistry, pre-veterinary medicine, and pre-pharmacy), and some natural resource majors (e.g., pre-forestry and agriculture). This sequence typically involves two years of chemistry--one year of general chemistry followed by one year of organic chemistry. However, there may be considerable variation in the second-year program. Not all majors are required to complete the full two-year sequence: some leave after the first semester, a larger group leaves at the end of the first year, and others leave after a third semester.

In addition to the above sequence, many comprehensive two-year institutions provide additional introductory courses tailored to the needs of other groups of students, including a two-year occupational program in chemical technology in locations where there is a concentration of employment opportunities for chemical technicians.

S7 **When there is significant variation from the curriculum mode described in these *Guidelines* (due to regional influences of the transfer colleges, demography, philosophy, or a unique curriculum organization), the chemistry program meets the goals of this model but in a different manner.**

The Society encourages diversity as well as quality in chemistry programs. Each institution should define its mission and develop chemistry programs that best achieve its mission. Change and experimentation preserve the vitality of chemistry education and provide timely career options for students. Programs that are experimental in both content and teaching methodology are strongly endorsed. Despite variations, all good programs maximize the amount of chemistry that students learn, help students develop positive attitudes toward science, and help

students recognize the contributions as well as the limitations of science and technology.

S8 **Chemistry courses and extracurricular activities include the relationship between chemistry and the other disciplines and the impact of chemistry on both technology and society.**

The obligation to provide for the educational needs of students in a variety of curricular and extracurricular areas is a challenge to the chemistry education profession. The profession can make a significant contribution both to the careers and to the intellectual development of all students and to their ability to function as citizens and community leaders in an increasingly scientific and technological society. Extracurricular activities that can contribute to an understanding of careers in chemistry and related disciplines as well as the interrelationships mentioned in this standard include ACS Student Affiliate Chapters, student science clubs, seminar and lecture series, and field trips.

S9 **Chemistry department personnel and all administrators are firmly committed to safe practices in the use and disposal of chemicals. The safety of students and faculty, as well as the protection of the environment, must be of the highest priority when curriculum and budget decisions are made. This includes**

- **instruction in safety concepts, attitudes, and practices in courses,**
- **proper instruction and implementation of safe practices in all laboratories, as well as in all lecture and laboratory demonstrations, and**
- **use of safety equipment and practices in accordance with all federal, state, and local regulations regarding the safe handling and disposal of chemicals and chemical wastes.**

A member of the chemistry faculty is designated to coordinate all aspects of the chemical safety program in cooperation with appropriate institutional and other departmental safety programs.

Specific references to safety in the chemistry program may be found in appropriate sections of these *Guidelines* along with references to safety procedures and standards.

S10 **Through local advisory committees, the college assesses the need for program changes to account for advances. In response to demonstrated needs, programs may be added, altered, or discontinued.**

This may include adding new occupational programs in which chemistry, biochemistry, chemical engineering, and/or chemical technology are combined with other disciplines and technologies, e.g., biotechnology technician, polymer technician, and scientific laboratory technician programs.

B. Course Scheduling

S11 **A schedule of chemistry courses satisfying these *Guidelines* is published annually and widely distributed, permitting students to schedule courses in proper sequence. The schedule provides reasonable flexibility for a student's orderly and normal progress into the transfer institution or the chosen occupational career.**

In this regard, the Conference on Critical Issues in Two-Year College Chemistry[5] stressed the need for colleges to offer all courses for science and engineering students at least once each academic year.

S12 **The college is flexible in scheduling its chemical technology courses. These courses are organized and scheduled to meet the needs of all its students, whether they are enrolled full-time, part-time, or for continuing education.**

S13 **The schedule of chemistry courses that service the various occupational programs is coordinated with the schedule of the other required courses for these programs.**

C. Course Prerequisites

S14 **The prerequisites for each chemistry course have been carefully considered by the faculty and are continuously validated by student success in the course. The**

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prerequisites must be clearly stated and publicized in the college catalogues, in the schedule of classes, and in all published curriculum brochures and program sheets.

Wide dissemination of the prerequisites for enrolling in each chemistry course will minimize registration problems, promote student planning, and ensure good public relations.

S15 **All those involved in admitting students to chemistry classes (administrators, counselors, faculty, etc.), understand the need for the stated prerequisites and adhere to them when approving student enrollment in chemistry courses.**

Adherence to the established prerequisites for chemistry courses is necessary for the maintenance of quality programs. The Conference on Critical Issues in Two-Year College Chemistry strongly recommended that colleges adhere to stated prerequisites for enrollment in a course. Failure to do so leads to increased student failure, increased drop rates, and a lowering of the quality of instruction. Additionally, qualified students with the necessary prerequisites may be deprived of enrolling in a class that becomes closed due to inadequate enforcement of the prerequisites.

S16 **Students deficient in the prerequisites for a given chemistry course are required to complete appropriate preparatory course(s) (in chemistry, mathematics, and/or developmental skills) designed to improve their success in the desired course or program.**

S17 **An effective assessment is made of each student's preparation and readiness for the course by testing, transcript evaluation, and counseling.**

D. The Spectrum of Introductory Chemistry Courses

S18 **Considering the college goals, the various programs, the characteristics of the student body, and the enrollment in the chemistry program and in the college, an optimum spectrum of introductory chemistry courses can be offered.**

Generally, introductory chemistry courses are completed during a full-time student's first year. It provides the first introduction to the study of chemistry for students who did not study it in high school. Among other topics, introductory courses deal with matter--its properties, structure, composition, and changes in composition, as well as changes in energy accompanying chemical and physical changes. These courses are general in nature and typically include material from one or more of the several subdisciplines of chemistry (e.g., inorganic, organic, analytical, physical, and biochemistry). The knowledge and skills of chemistry needed by students in certain occupationally oriented programs is so specialized, and the time allowed for acquiring it is so limited, that introductory courses for these programs include highly selective topics. Introductory chemistry courses, differentiated either by the student's major or level of preparation, include

- chemistry for the science and engineering professions,
- chemistry for chemistry-based technology occupations,
- chemistry for the nonscience and/or nontechnology students,
- chemistry for allied health and other biology-related occupations,
- chemistry for engineering technologies and related occupations,
- chemistry for underprepared students, and
- chemistry for other occupational or special-interest groups

Due to differing needs, interests, and backgrounds of student groups for whom they are intended, the aforementioned courses may vary in content, orientation, and level of chemical and mathematical sophistication. Some of these courses stress laboratory work and related knowledge and skills (especially mathematics) more than introductory courses in the other sciences. For either pragmatic or philosophical reasons, a given introductory course may serve the needs of two or more of the student groups listed above (e.g., both preparatory and general education students, or both allied health occupational and general education students.) However, with such combinations, care must be taken to ensure that the needs of any group are not compromised.

The general chemistry course is the foundation course of the program. Once designed, it greatly influences the characteristics of the second-year and preparatory courses as well as the other introductory chemistry course offerings. The general chemistry and preparatory courses are discussed briefly in the next two sections, prior to considering the chemistry transfer program, whereas introductory chemistry courses devoted to chemical technology programs and other majors are discussed in later sections.[9]

E. General Chemistry for Science and Engineering Majors

S19 **The minimum prerequisites for the first term of the general chemistry course for science and engineering majors sequence are the equivalent of one year of high school chemistry and three years of high school mathematics, including two years of algebra. For students deficient in these prerequisites, the college offers and requires the successful completion of a preparatory chemistry course as well as the necessary mathematics courses.**

S20 **Although the general chemistry course sequence is organized around traditional chemistry topics, it includes related major developments in such disciplines as biology, geology, physics, mathematics, and engineering.**

F. Preparatory Chemistry Courses

S21 **The curriculum includes a preparatory course for students who intend to continue into the general chemistry course and who have not previously studied chemistry or have inadequate preparation in the subject. It is designed to improve their chemistry knowledge and skills before they enroll in one of the other introductory chemistry courses. The preparatory course includes a limited introduction to the basic terminology and principles of chemistry including, among others, modern concepts of atomic structure, bonding, oxidation numbers, formulas, equations, stoichiometry, and chemical reactions. It emphasizes chemical calculations and includes one laboratory session per week.**

A preparatory course is helpful and, in many colleges, essential to maintaining high standards in the general chemistry course. When combined with an effective student assessment and chemistry placement program, the preparatory course helps ensure that students entering the general chemistry sequence are well prepared. The caution in (S13) regarding combining functions into a single course is particularly significant with respect to the preparatory course.

G. Chemistry Transfer Programs

S22 **Science, mathematics, and engineering courses offered for chemistry and other science and engineering majors are carefully articulated with the institutions to which most students transfer.**

Normally, transfer programs for chemistry, biochemistry, chemical engineering, biology, and health professionals include one year of general chemistry followed by one year of organic chemistry. However, some two-year colleges offer analytical chemistry or biochemistry in the second year instead of the full year of organic to satisfy the requirements of the local transfer institutions. Certain transfer students do not require the full two-year sequence; consequently, enrollment may be considerably smaller in the second-year courses than in the first-year sequence.

Ongoing articulation programs with several transfer institutions are necessary. This is particularly true where chemistry programs at senior institutions in a given geographical region are not uniform and when four-year institutions change their chemistry curriculum. Transfer institutions that are unfamiliar with the two-year college program may not consider the two-year college experience to be equivalent to that of the first two years of their institution and may not accept certain courses for transfers. A good articulation program is apt to prevent such problems.

Students wishing to acquire American Chemical Society certification as a chemistry major at the completion of the bachelor's degree should be aware of the approved program as outlined in the publication, *Undergraduate Professional Education in Chemistry: Guidelines and Evaluation Procedures*.[10,11] At the time of

preparation of these *Guidelines*, the Committee on Professional Training (CPT) was developing a similar set of guidelines for a major in biochemistry. Chemical engineering programs are approved by the Accreditation Board for Engineering and Technology, which includes representatives of the American Institute of Chemical Engineers.

For a two-year college chemistry transfer program to match the first two years of an ACS-certified transfer program in chemistry, it must offer structured courses consisting of a minimum of 180 hours of lecture classroom work and a minimum of 240 hours of laboratory work. These hours normally are spread over a minimum of four semesters or six quarters, starting with the first term of a general chemistry (for science majors) course. Each course is four or five credit-hours and includes a minimum of three lecture hours and three or four laboratory hours per week. Many two-year colleges exceed these minimums because their transfer institutions do so and/or because they have found it necessary or desirable to do so.

Some general chemistry courses in four-year institutions contain sufficient analytical or inorganic chemistry to satisfy some of the CPT certification requirements in these areas. Two-year colleges that offer equivalent courses, through careful articulation with their transfer institutions, should find that their students receive similar consideration by the transfer institution.

In addition to the chemistry and mathematics prerequisites described earlier, CPT recommends high school physics as a prerequisite and concurrent enrollment in calculus for admission into the general chemistry course. The physics and calculus recommendation, while desirable, may not be feasible for certain two-year colleges because transfer institutions do not require them. However, the CPT requirement that the general chemistry (for chemistry and other science majors) sequence be a prerequisite for the second-year organic course is valid at two-year colleges.

S23 **Chemistry courses for science and engineering majors incorporate a historical perspective as well as references to current developments in chemistry. Attention is given to chemical safety, the systematic use of the chemical literature, and computer applications in chemistry.**

Emphasis on pure theory can neglect the aesthetic, ethical, humanistic, and practical aspects of chemistry. Consideration of current developments in chemistry include biochemistry, polymer chemistry, and applied chemistry, among other topics.

S24 **Lecture experiments and demonstrations are used when appropriate in the science and engineering major chemistry courses in presenting descriptive material and in generating lasting interest in chemical phenomena.[12] Up-to-date learning aids and media resources, such as computer-aided instruction, audio-visual presentations, and programmed instructional materials, are used to enhance students' interest and learning.**

S25 **Laboratory work in chemistry courses for science and engineering majors is designed to give students hands-on experience in working with chemical phenomena and instrumentation. It is also designed to develop the competence and self-confidence required to**

- **gain a fuller, more practical understanding of and appreciation for chemical concepts,**
- **plan and execute experiments through the use of the chemical literature,**
- **anticipate, recognize, and respond properly to potential hazards in chemical procedures,**
- **keep neat, complete experimental records,**
- **synthesize and characterize inorganic and organic compounds,**
- **perform accurate quantitative measurements,**
- **analyze data statistically, assess the reliability of experimental results, and discuss the sources of systematic and random error in experiments,**
- **interpret experimental results and draw reasonable conclusions, and**
- **communicate effectively through oral and written reports.**

S26 **Laboratory work gives students hands-on experience and an opportunity to acquire competence and self-confidence in the use and understanding of modern laboratory instruments at a level equivalent to that of students in the major transfer institutions.**

Typically, most laboratories should be equipped with
- analytical balances,
- pH meters,
- recording spectrophotometers (infrared, ultraviolet, and visible), and
- gas chromatographs,

and further, may include
- nuclear magnetic resonance spectrometers,
- liquid chromatographs,
- atomic absorption spectrophotometers and flame emission photometers,
- automatic temperature control devices, and
- computerized data acquisition stations.

S27 **The second-year program, especially organic chemistry, includes training and experience in the use of information from the enormous and rapidly expanding chemical literature equivalent to that in the major transfer institutions.**

Because of the increasing volume and complexity of chemical literature, students are no longer able to acquire skills in information retrieval without some formal instruction. These skills (e.g., using *Chemical Abstracts* and other compilations) may be taught through coordinated instruction, by integrating them into courses, and by library exercises and/or research papers as well as on-line interactive computer file experiences. Cooperative library arrangements with nearby four-year institutions can facilitate this [see (S90)].

S28 **The department provides self-instructional techniques, such as audio, video, and computer courses, as alternative modes to supplement traditional classroom instruction as well as for single-topic short courses.**

Self-instruction programs are available to help students reach a portion of their educational goals without the help of the teacher. Materials are available on such topics as catalysis, chemical engineering, industrial chemistry, polymers, surfaces, and the use of chemical literature. Self-instructional courses on special topics might be offered in cooperation with ACS local sections or local industry. They could be especially useful to those employed in the chemical industry who are not enrolled in two-year colleges.[13]

H. Chemical Technology Programs

S29 **The chemical technology program includes specific training that provides students with entry-level skills for employment as chemical technicians. Additionally, there is a continuing education program for currently employed chemical technicians, including both those who are graduates of a chemical technology program and those who have entered the field without such an education.**

Professional chemists often rely on chemical technicians to make measurements, perform analyses, and carry out experiments. Therefore the technician program must provide the student with the knowledge and skills required to function in this capacity.

S30 **The core curriculum for the chemical technology program includes, as a minimum,**
- **basic chemistry (general, fundamentals, principles) including inorganic chemistry,**
- **analytical chemistry (quantitative analysis),**
- **organic chemistry, and**
- **chemical instrumentation.**

The nonchemistry courses in the core program include, at least,
- **an academic-year sequence of college courses in each of the following: mathematics up through algebra/trigonometry, English composition, humanities/social sciences, and physics or biology; and**

- **a course in computers/computing.**

The program for chemical technology majors can be organized in a number of ways reflecting the institution's missions, the available facilities, and the interests and capabilities of the faculty and students. The Society recognizes and encourages approaches that cover the core material in different ways. Some chemical technology programs use a traditional (lecture, recitation, laboratory) approach, whereas others use an integrated lecture-recitation-laboratory format. Regardless of the approach used, laboratory work must enable students to develop proficiency in laboratory techniques in addition to demonstrating basic principles of chemistry.

A student in an associate degree chemical technician program has the following minimum experience in chemistry:

- **170-180 contact hours of classroom work. Up to 30 of these hours may consist of supervised tutorials, active participation in seminars, or supervised self-study programs.**
- **450-500 contact hours of laboratory work, principally as part of a structured course. However, up to 100 hours may be from cooperative industrial experience. If more than 100 hours of cooperative experience is to be substituted, students must prepare detailed project reports for evaluation by the faculty.**

S32 **Not less than one-half nor more than two-thirds of the two-year chemical technology program should be devoted to the core curriculum in chemistry, which is spread approximately equally over the areas of chemistry (including inorganic, analytical, and organic) and chemical instrumentation.**

S33 **Wherever appropriate, attention should be given to examples of biochemistry, polymer chemistry, applied chemistry, chemical safety, and the systematic use of the chemical literature. Computers and computer applications are integrated into lecture and/or laboratory portions of the core curriculum.**

S34 **Laboratory experience in the chemical technology core curriculum reflects the career orientation of the program in that it helps students develop a wide range of laboratory skills, gives them hands-on knowledge of chemistry using state-of-the-art instrumentation and equipment, and fosters competence and self-confidence, enabling them to**

- **use chemical literature to plan and execute experiments,**
- **anticipate, recognize, and respond properly to hazards encountered in chemical manipulations, including being aware of hazardous substances and how to handle and dispose of them and abiding by all safety regulations pertaining to the laboratory area,**
- **keep neat, complete well-organized experimental records,**
- **synthesize and characterize inorganic and organic compounds,**
- **perform accurate quantitative measurements and related calculations,**
- **understand and use up-to-date instruments, particularly NMR, IR, FTIR, ultraviolet-visible, and AA spectrometers, gas and high-pressure liquid chromatographs, electrochemical instruments, laboratory computers including computerized data stations, analytical balances, and pH meters, as well as minor instrument trouble shooting and repair, and**
- **communicate effectively through oral and written reports.**

S35 **The laboratory experiments in the chemical technology program are realistic, stressing practical applications of standard techniques used in modern technology.**

S36 **Students completing the chemical technology program are able to retrieve specific information from the chemical literature and demonstrate that they understand the organization and use of both printed information sources and computer data bases.**

Because of the increasing volume and complexity of chemical literature, students are no longer able to acquire skills in information retrieval without some formal instruction. These skills may be taught through coordinated instruction, by

integrating them into courses, and by library exercises and on-line interactive computer file experiences. Students need to understand the organization and use of the printed information sources in order to use the computer data bases to best advantage.

S37 **The institution is encouraged to participate, where possible, with local industries in a cooperative education program,[14] and to provide an opportunity for students to work in industrial positions prior to completing a chemical technology program. Such academic-industrial interface programs are designed to provide students with**
- **an appreciation of technology,**
- **exposure to team research, interdisciplinary research, societal problems, and points of view complementary to those of academia,**
- **exposure to both pure and applied chemistry,**
- **an opportunity to use sophisticated instruments in a practical setting,**
- **early professional experience, contacts, and information for career planning, and**
- **practice in preparing and delivering oral and written reports .**

S38 **The institution cooperates with local chemical industries in a variety of ways, including the establishment of a chemical technology program advisory committee. The advisory committee advises the college on the needs of the local region for chemical technology education and the faculty on the chemistry course content for chemical technology students with respect to the latest equipment and laboratory techniques and methods. The committee also should assist in planning field trips, providing persons for a speakers bureau, facilitating the exchange of faculty and industrial chemists, arranging job interviews for future graduates of the program, and developing strategies for recruiting students.**

S39 **All core courses in the chemical technology program are scheduled and offered on a regular basis, ensuring that students can take them in proper sequence.[15]**

I. Chemistry Courses for Other Programs

S40 **Considering the number of students involved and the demands of the occupational curricula and faculty, the college provides as many separate courses as possible for each of the following student groups:**
- **nonscience/nontechnology students (e.g., the arts, liberal arts, business, etc.)**
- **students majoring in one of the health professions/occupations**
- **students majoring in engineering technology and related occupations**
- **students majoring in other occupations and special-interest groups (e.g., fire science, police science, auto mechanics, etc.)**

Institutional policies and pragmatic considerations, which vary widely, make an impact on these courses. Some colleges may combine two or more groups in the same course. This, however, should not compromise the needs of students in any group. In other cases, the program is so completely determined, with respect to the amount of time devoted to chemistry, the topical coverage required, and the scheduling of classes, that combining groups is precluded.

1. Nonscience/nontechnology students

S41 **If a chemistry course for nonscience students is offered, it is transferable and satisfies the general education science requirement for graduation of both the local and transfer institution. The mathematical requirement is minimal; usually elementary algebra is the only prerequisite. The goal of the course is to acquaint students with the fundamentals of chemistry and its relationship to science, technology, and society. It emphasizes what chemistry is about rather than facts, laws, and theories.**

Topics covered in these courses, which are usually interdisciplinary in nature, may range from environmental chemistry to the history of chemistry. Typically, such courses carry four or five semester credit-hours, consisting of three or four hours of lecture and appropriate laboratory sessions per week as described in (S42).

S42 **The general education chemistry course includes a laboratory consisting of at least one two- or three-hour laboratory session per week. The laboratory work gives the students a brief but first-hand introduction to the properties of chemicals and to what chemists do. It uses the methods of science to relate chemistry to the students' everyday lives. By giving students hands-on experience, the laboratory work will help them develop the ability to**

- **follow directions and use laboratory apparatus to perform quantitative measurements,**
- **interpret experimental results,**
- **draw reasonable conclusions from observations,**
- **communicate effectively through oral and/or written reports, and**
- **learn laboratory safety by practicing proper safety procedures and learning how to deal with hazards inherent in experiments.**

The *Tomorrow* report[16] emphasizes that, whether they are taught to nonscientists, science majors, or chemistry majors, foundation courses in chemistry at the college level must include a substantial component of significant laboratory work.

2. Allied health professions/occupations

S43 **For allied health transfer students (e.g., nursing, physical therapy, home economics, etc.) and other biology-related majors (e.g., agriculture, natural resources, etc.) that do not require general chemistry, the institution offers a course sequence comparable to that required at the institutions to which most of their students transfer.**

Increasingly, this is a one-year sequence that includes carefully selected topics from general and inorganic chemistry followed by topics in organic chemistry and biochemistry. Applications to living systems are emphasized. Generally, the first term requires algebra, and the prerequisite for the second term is satisfactory completion of the first term. Typically, both terms have four semester credit-hours, with three to four hours of lecture and two to three hours of laboratory per week, for a total of eight semester credit-hours. When no organic chemistry is included in the first semester, the preparatory course or the first semester of the science majors sequence may serve as the prerequisite for the second semester. If organic chemistry is included in the first semester, this is generally not feasible.

S44 **Laboratory work includes everything mentioned for the nonscience majors course in (S41) as well as the following:**

- **keeping neat, complete experimental records;**
- **synthesizing and characterizing compounds;**
- **learning special techniques that are used in the health professions (e.g., pipetting, titrating, and colorimetric determinations);**
- **using such instruments as pH meters and visible wavelength spectrophotometers, gas chromatographs, and laboratory computers.**

S45 **If the institution has two-year programs in the health professions, there is a minimum of a one-term chemistry course to service these programs. The content of this course is developed in cooperation with the faculty and advisory committees for these occupational programs. Prerequisites for this course must be consistent with those of the programs serviced.**

Generally, these courses are four or five semester credit-hours and include a two- or three-hour laboratory per week. They are less demanding both in prerequisites and the chemistry covered than the course for the baccalaureate program. They include topics in general chemistry, inorganic chemistry, organic chemistry, and biochemistry, stressing applications to living systems. Laboratory work is similar to that for the nonscience major course (S42) and may include certain laboratory techniques of the two-semester sequence for allied health programs (S44) but few of the instrumental techniques.

3. Engineering technology and related occupations

S46 **For institutions with engineering technology programs that require a background in**

chemistry, there is an appropriate chemistry course offered. The content of this course is developed in cooperation with the faculty and advisory committees for these programs, with prerequisites consistent with those of the programs serviced.

Courses for engineering technology students are generally concerned with selected topics in chemistry and their applications to material science and engineering-related activities. Some colleges provide either a one-term or one-year course that concentrates on such topics as metals, semiconductors, corrosion, polymers, electrochemistry, and so on.

Laboratory work in these courses includes techniques, instruments, and related calculations specific to the applic. .ions of chemistry in the technologies. Students are expected to perform accurate measurements, keep neat experimental records, and communicate effectively through oral and written reports. The course requires that students become familiar enough with the library to retrieve information, especially that which relates to their specific technology.

4. Other occupations and special-interest groups

S47 **In institutions where occupational programs other than those discussed above (e.g., police science, fire science, auto mechanics) or where other departments, local industries, or community special-interest groups have indicated a need for a special chemistry course or program, the college has responded by satisfying the need. Such courses are assigned to the chemistry faculty who develop them in cooperation with the occupational faculty or representatives of the industries or special-interest groups concerned. These courses are either a part of the regular chemistry curriculum or included as the chemistry component in the continuing education, community services, or contract education program of the college.**

V. FACULTY AND SUPPORTING STAFF

S48 **The minimum academic preparation required of a chemistry faculty member is a master's degree in a discipline of chemistry (including biochemistry and chemical engineering). In addition, faculty in a chemical technology program are required to have industrial experience and to be familiar with applications of chemical technology. In the selection of chemistry and chemical technology faculty, emphasis is placed on both a competence in chemistry and an ability to communicate an understanding of chemistry to others.**

Further academic training and research is highly desirable, particularly if it stresses depth as well as breadth of knowledge in chemistry. Refer to section on "Use of Guidelines" in the Introduction for an explanation of how to deal with existing deviations from this and other standards.

S49 **There is evidence that all chemistry faculty members keep abreast of current developments in chemistry, chemistry education, and the applications of chemical technology in our society.**

S50 **The institution has an active program to assure equal opportunity in professional and technical employment for women, minorities, and the handicapped. If equal opportunities do not appear to exist, the institution is actively planning to correct the situation.**

S51 **Full-time faculty size is adequate to teach the full range of chemistry courses on a regular basis to meet the needs of students as outlined in the curriculum section of these *Guidelines*.**

Faculty size is determined by the number of different courses offered, the number of sections taught, and the number of students enrolled in the courses. Optimum programs require at least two full-time faculty members or the equivalent in qualified, full-time personnel. Full-time faculty are sometimes given other duties

along with their teaching assignments, and teaching load credit is granted for these duties. Consequently, they are not full-time chemistry faculty members. In such situations, the equivalent of two full-time faculty requires a total of two full-time teaching loads distributed among full-time faculty who possess a minimum of a master's degree in chemistry.

S52 **The number of credit hours taught by part-time faculty does not exceed 25% of the total chemistry offerings.**

Part-time faculty are defined as part-time employees of the college.

S53 **Full-time faculty from other disciplines are not assigned to teach chemistry courses unless they meet the minimum requirement of a master's degree or its equivalent in chemistry, and, for chemical technology programs, also have some industrial experience.**

S54 **Policies regarding salaries, teaching loads, overloads, promotions, tenure and/or continuing contracts, leave policies (sabbatical or other), and hiring practices are sound enough to maintain good faculty morale and to attract and retain chemistry faculty of quality.**

S55 **Teaching loads are such that, after fulfilling all classroom and laboratory teaching responsibilities, meeting required office hours, and satisfying committee assignments, faculty have adequate time and energy for**

- **continuing course and program development,**
- **study to stay abreast of new developments in their educational field,**
- **participation in professional activities, and**
- **instructional research to improve teaching effectiveness.**

S56 **For purposes of faculty load determination, each laboratory contact hour counts the same as a lecture contact hour in the classroom.**

Supervision of a student laboratory, including the preparation for the experimental work and the grading of the laboratory reports, demands time and energy of a faculty member that is equivalent to that required for the preparation and presentation of a lecture. For purposes of establishing teaching-load guidelines, the definition of a contact hour is 50 minutes of time in which a faculty member is required to be present in a classroom or 60 minutes of laboratory teaching or supervising students.

S57 **The normal teaching load in chemistry is 15 contact hours per week or less and/or 450 student contact hours per week or less.**

A student contact hour is given by the number of students multiplied by the number of contact hours. Greater loads can be justified only in terms of factors such as smaller class sizes or fewer numbers of preparations. In such instances, the work load is compared to the standard load, which is based on two courses and students from two or more laboratory sections combined into a lecture section with an average of 30 students per contact hour or less. Teaching loads that exceed this standard risk lowering the quality of the chemistry program.[17] For this reason, teaching loads and contact hours are given considerable weight by consultants when they evaluate a chemistry program and make recommendations for improvement.

S58 **No faculty member is responsible for more than 25 students in a laboratory at one time.**

This standard is based on prudent safety considerations and practice as recommended in the ACS publication, *Safety in Academic Chemistry Laboratories*.[18]

S59 **Secretarial, stockroom, or technical staff is available to relieve faculty members of the routine chores that detract from academic responsibilities.**

Experience has shown that, to relieve faculty of routine laboratory preparation

chores, at least one full-time laboratory technician for every four full-time equivalents of chemistry faculty teaching loads in chemistry is needed. Any less technician assistance in preparing laboratory solutions and setting up equipment produces undesirable compromises in the laboratory program and in the use of lecture experiments and demonstrations. Colleges with fewer than four full-time chemistry faculty can best serve the chemistry program by hiring full-time laboratory technicians for multiple-discipline assignments, using the same 4:1 ratio. Experience has shown that part-time and student help cannot adequately substitute for full-time laboratory technicians; rather, they often increase the burden on the faculty.

VI. STUDENTS AND COUNSELING

S60 **The primary role of the academic advisor, whether a full-time counselor or a faculty advisor, is to assist students in developing educational goals that are consistent with the students' abilities and interests.**

Because of the multiplicity of programs and the differing requirements for chemistry in the various programs, the counseling and guidance function is particularly important in two-year colleges. The situation is complicated further by the extreme variations among the students in terms of the knowledge and skills necessary for success in chemistry.

Furthermore, the Society encourages two-year colleges to provide information to chemistry students regarding transfer programs, allowing them to combine a basic chemistry education with studies in other disciplines. For example, a major in chemistry with supporting work in biology is recognized as a wise program for students planning careers in medicine, dentistry, or pharmacy. In addition, many careers in the chemical industry, government, and other areas are open to graduates who have a good background in chemistry combined with such subjects as computer science, law, economics, environmental science, and library science, as well as history, literature, and philosophy.

Colleges are encouraged to utilize discipline-specific counselors and advisors so as to promote familiarity with chemistry and chemistry-related programs and to facilitate articulation with both the four-year colleges and industry.

S61 **Counselors and advisors are familiar with the career opportunities for students in both occupational programs and transfer programs. They also are familiar with the academic preparation necessary for entry into the various chemistry courses. They encourage students with strong interests and abilities in chemistry to continue their education in chemistry, biochemistry, chemical engineering, or chemical technology.[19]**

S62 **Counselors and advisors advise transfer students in their selection of chemistry and related courses to ensure that they will coordinate and articulate successfully with those of the senior institutions to which they plan to transfer. Students anticipating transfer to a four-year institution are counseled to complete all terms of sequential courses (e.g., the general chemistry sequence and the organic chemistry sequence as well as other science and mathematics sequences) prior to transfer.**

Counselors and advisors have established clear lines of communication with the chemistry and other science departments of the schools to which students normally transfer, as well as with the broader college articulation offices.

S63 **Chemistry faculty and science administrators work closely with counselors to make sure that the information all three groups possess is up to date and accurate.**

S64 **Students in chemical technology programs are encouraged by their counselor or advisor to elect courses in communications, business administration, economics,**

marketing, engineering, electronics, and microbiology as a means of broadening their career options.

Many career opportunities for chemical technicians are in industry or in various independent or government laboratories. Knowledge in the subject areas listed herein is valuable.

S65 **Colleges with chemical technology programs have one or more members of the chemical technology faculty responsible, with appropriate teaching load credit, for**
- **monitoring the employment needs of industry,**
- **assisting in the planning of or actively engaging in the recruiting of students,**
- **coordinating the job placement of chemical technology graduates, and**
- **conducting detailed follow-up studies of former students of the chemical technology program.**

S66 **Colleges have faculty participate in activities that serve to develop their understanding of the chemical industry, the relationship between chemistry and the other disciplines, and the mutual impact of chemistry on technology and society. The faculty can then, in turn, encourage their students to participate in such activities.**

These activities include ACS meetings at the national, regional, and local levels; advisory committee meetings; technician affiliate group meetings; student affiliate chapter meetings; and others.

VII. ARTICULATION WITH SECONDARY SCHOOLS, TRANSFER INSTITUTIONS, AND INDUSTRY

The quality and success of chemistry programs in two-year colleges is dependent upon articulation with secondary schools, transfer institutions, and industry in the local area. The reader is also reminded of the several earlier standards (S22, S38) concerned with articulation.

S67 **The college works with appropriate faculty and administration of its "feeder" high schools and with other potential sources of students to keep them aware of the curriculum requirements and career potentials for the graduates of its transfer and occupational chemistry programs.**

S68 **The chemistry faculty, administrators, and counselor/advisors are informed of curriculum revision and changes in transfer requirements at the major transfer institutions. This information is used when necessary to revise the chemistry courses and sequences and the counseling and advising.**

S69 **The college should conduct regular and detailed follow-up studies of its transfer students as well as those in the occupational programs and communicate this information, in a timely manner, to the faculty, administrators, and counselor or advisors. These follow-up studies include both academic and/or employment data and former student opinions.**

S70 **The college has sharing agreements with neighboring four-year and two-year institutions and industries, effectively expanding the chemistry offerings, library, laboratory facilities, and expensive instrumentation available.**

Programs at two-year colleges are strengthened and enriched by the utilization of resources from other nearby agencies. Second-year and specialized occupational courses especially can be extended and enriched in this manner. Likewise, availability of research facilities for use by faculty members and independent study

students may be increased.

If two or more institutions in the same geographical area are unable to offer a complete two-year college chemistry program individually, they might combine resources and facilities to provide a full, strong two-year chemistry program. Furthermore, such an arrangement could provide the specialized chemistry needs for occupational programs and the general education needs in science for the nonscience students.

S71 **The college assists schools in its local area with the enrichment of their chemistry programs.**

S72 **The college sponsors programs that help promote a favorable image of chemistry among the general public.**

VIII. FACILITIES

A. Lecture Rooms and Office Space

S73 **The chemistry classrooms and offices are located near the instructional laboratories and preparation facilities.**

S74 **The chemistry classrooms meet modern standards of lighting, ventilation, and comfort.**

S75 **Classrooms have adequate provision for using all types of audiovisual aids, and the availability of a hood (either permanent or portable) for demonstrating chemical phenomena. Equipment for mounting and displaying charts is available. Easy access for laboratory carts to carry demonstration materials is provided.**

S76 **Faculty offices are readily available to students and located so as to encourage faculty-student contact.**

S77 **Faculty offices and classrooms are accessible to the handicapped.**

B. Student Instructional Laboratories

S78 **Laboratories are well lighted and ventilated, and are equipped with such services as gas, water, and electric power.**

S79 **Neither the laboratory program nor the students' and staff's well-being are compromised by a lack of well-maintained, working fume hoods and hood space.**

S80 **There is a minimum of 28 square feet of laboratory space per student for the introductory courses and 42 square feet per student for second-year courses.**

S81 **The laboratories are fully equipped with well-maintained and properly functioning safety features such as eye wash, safety shower, fire blanket, and fire extinguishers. Safety instructions are posted in the laboratory, and safety goggles must be worn by everyone in the laboratory and preparation areas.**

The college faculty and administration should refer to the publications mentioned in footnotes 6, 18, and 20 for additional information on safety in the academic laboratories and in the ordering, handling, and disposal of chemical waste materials.

S82 **Laboratory facilities comply with the regulations of federal, state, and local agencies.**

S83 **Laboratories are located to provide convenient routes to stockrooms and preparation areas.**

S84 **Laboratory facilities have provisions for the safe instruction of the physically handicapped.**[20]

S85 **For safe supervision of students, laboratories should have no more than 25 stations. Where more stations exist, no more than 25 students are assigned to an individual laboratory instructor. See (S58).**

C. Instructional Support Facilities

S86 **Service areas, such as the rooms for storage and preparation and auxiliary instructional areas for faculty and student special projects, are conveniently located and large enough to provide for the needs of the students and the faculty for instrument, equipment, and computer utilization, as well as storage, preparation, and study.**

Other such areas include balance rooms, instrument rooms, computer rooms, study areas (with access to library resources), and special storage and receiving areas.

D. Library

S87 **The chemistry library collection is within or near the science building. It consists of holdings commensurate with the size and nature of the chemistry offerings and the research activity of the students and staff.**

S88 **The library collection includes a minimum of 10 current chemistry and related science periodicals, plus a range of other reference materials suitable for the course offerings of the department. The collection includes back issues of five years or more for each of these periodicals.**

S89 **For institutions with a central, main library, a departmental or science reading room is strongly recommended. Such a room would have the important reference materials and current periodicals close at hand when needed by staff and students, especially those engaged in advanced courses, research, and independent study.**

S90 **The college has cooperative library arrangements with nearby two- and four-year colleges as well as with local industries.**

Please address comments and questions regarding these *Guidelines* or any other ACS programs, publications, and services to the Office of College Chemistry, American Chemical Society, 1155 Sixteenth Street, N.W., Washington, DC 20036.

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Footnotes

[1]Throughout this document the term "chemistry program(s)" will be used to refer to all parts of chemistry and/or chemical technology programs.

[2]Available from the Office of College Chemistry, American Chemical Society.

[3]Available from the Office of College Chemistry, American Chemical Society.

[4]The Conference on Critical Issues in Two-Year College Chemistry has recommended that the Commission on Postsecondary Accreditation, the American Association of Community and Junior Colleges, and the American Chemical Society cooperate to form a task force to study ways in which the regional accrediting associations and the scientific disciplinary organizations can work together to improve the quality of two-year college science education through the regional accrediting process. Copies of the report of the conference are available from the Office of College Chemistry, American Chemical Society.

[5]The American Chemical Society does not have any approval or accreditation programs for chemistry in the two-year colleges.

[6]See *Less is Better*, available from the Office of Government Relations and Science Policy, American Chemical Society.

[7]Colleges are experiencing, in increasing numbers, students for whom English is not the native language. Colleges are encouraged to develop experimental programs designed to assist these students whose cultural backgrounds do not provide experiences similar to those of the average American student.

[8]See footnote 4.

[9]The ACS will periodically publish supplementary documents to these *Guidelines*, including suggestions for course content and other curriculum-instruction matters.

[10]Available from the Committee on Professional Training, American Chemical Society.

[11]Two-year colleges must provide experience in mathematics, physics, biology, computer science, and other required subjects comparable to those required in the major transfer institutions for majors in chemistry, biochemistry, and chemical engineering.

[12]Refer to {S9} regarding appropriate safety considerations.

[13]Refer to ACS continuing education materials and their availability. Write to Continuing Education, American Chemical Society.

[14]For further information regarding co-op programs, write the Academic-Industrial Education Program, American Chemical Society.

[15]Refer to {S12} for additional comments on scheduling of chemical technology courses.

[16]The 1984 Report of the Task Force for the Study of Chemistry Education in the United States, *Tomorrow*, recommends that the ACS establish guidelines regarding the appropriate balance among the fundamental principles of chemistry, applications of chemistry, and the place and role of the chemical sciences in contemporary society for the college-level chemistry courses for nonscience majors. Colleges are encouraged to report on their experiences in balancing these factors. Copies of the report are available from the Education Division, American Chemical Society.

[17]This standard refers to the normal assigned teaching load. Any teaching assignments over this load should be examined carefully to ensure that the faculty member's total responsibilities to the college do not jeopardize the quality of the program.

[18]Copies may be obtained from the Office of College Chemistry, American Chemical Society.

[19]ACS has material that counselors and advisors might find helpful. Write Career Services Program, American Chemical Society.

[20]Copies of *Teaching Chemistry to Physically Handicapped Students* can be obtained from the Department of Professional Services, Committee on the Handicapped, American Chemical Society.