2019 ACS Chemical Safety Education Summit

Detailed Agenda

Thursday, February 28

International Year of the Periodic Table Reception, dinner on your own but will be supported according to ACS policy on travel expenses.

Friday, March 1

Time	Facilitator	Details
7:30 AM		**Arrival and Breakfast**
8:30 AM; 10 minutes	Peter Dorhout and Bonnie Charpentier	**OPENING** The ACS Immediate Past President and ACS President will open the Summit with a welcome and outline their goals for the meeting.
8:40 AM; 40 minutes	Sammye Sigmann	**INTRODUCTIONS** **Preliminary small group icebreaker discussion:** Allow 10 minutes for small groups. Individual Introductions to the Whole Group (30 minutes) - Name and Organization - Chemical Safety Education Role - Top three chemical safety education opportunities in your role
9:20; 15 minutes	Jennifer Campbell	**REVIEW OF LOGISTICS** Review logistics and expectations for the meeting's discussions
9:35; 15 minutes	Ralph Stuart	**OVERVIEW OF THE 2018 SUMMIT AND ITS OUTCOMES**
9:50 AM; 15 minutes		**BREAK**
10:05; 45 minutes	Susan Shih	**PRESENTATIONS ON THE EXPLORATORY QUESTIONS** ○ Dawn Mason – Employer's Needs and Expectations ○ Dave Finster – Technical Chemical Safety Education ○ Mary Kirchhoff –Cognate Skills ○ Ralph Stuart – Safety Culture Education
10:50 15 minutes	ACS Staff	**Overview of ACS Chemical Education Resources and Programs.**

Time	Facilitator	Details
11:05 AM; 40 minutes	Dawn Mason	**MORNING SUMMARY** Large group discussion around these questions: • *What did you learn this morning?* • *What reinforced something for you in a meaningful way?* • *What aspects of chemical safety education are missing in the discussion so far?* • *What resources can ACS provide for practitioners and the broader chemistry enterprise in addressing chemical safety education practices?* Review the exploratory questions and edit as appropriate for this afternoon's buzz session. We expect that there will be 3 exploratory questions as well as a review of the 2018 proposals to be established for Friday afternoon's discussions.
11:45 AM 75 minutes		**Lunch and Recreation** **Also Networking with ACS Staff and Resources will be available for Browsing.**
1:00 PM 10 minutes	Mary Kirchhoff	**Welcome Remarks** Thomas Connelly
1:10 PM; 3.5 hours	Jennifer Campbell	**BUZZ SESSION –PLEASE SEE PAGE 12 FOR ADDITIONAL INFORMATION ABOUT THIS SESSION.** The goal of the buzz sessions is to provide the opportunity to discuss the exploratory questions and the 2018 Education Proposals in small groups so that everyone has a chance to contribute and be heard. Explain the Buzz Session process: - 4 table groups, each table is assigned an exploratory question to be discussed for 15 minutes; key points will be captured and added to during each round of discussions - Participants rotate between tables in 4 rounds - At 3 PM, the original group returns to starting table, reviews all notes and prepares questions for the large group to help clarify points documented - Each group will prepare a summary chart of the responses to the questions.
4:40 PM; 15 minutes	Sue Wiediger	**SUMMARY AND WRAP UP OF DAY 1** Purpose: to briefly summarize the key activities of the day and identify the 5 planning topics for Saturday's work Ask for any final comments about how the day went.
6:00 PM		**ACS CHEMICAL SAFETY EDUCATION SUMMIT DINNER** Dinner will be held at Occidental Grill & Seafood located at 1475 Pennsylvania Ave NW Washington, DC 20004

Saturday, March 2

Time	Facilitator	Details
7:30 AM		**BREAKFAST AVAILABLE**
8:30 AM 45 minutes	Peter Dorhout and Bonnie Charpentier	Within the current chemistry curriculum, how and where are chemists best educated in a safety culture ethos? How can a safety culture ethos support and be supported by inclusive laboratory culture, particularly as it relates to gender?
9:15 15 minutes	Richard Schwenz	**REVIEW OF DAY 1'S WORK** *What were your key learnings from yesterday?* Review the 5 questions for strategic planning from the Planning Committee and form groups to work on each question.
9:30 2 hours	Ralph Stuart	**DEVELOPING STRATEGIES** Purpose: to develop recommendations for advancing chemical safety education, including proposed collaborations, key indicators of success, and possible input for the symposium Explain the group process - 5 discussion groups; each group will develop a strategy that identifies the project scope and goals, the stakeholders to be involved and indicators of success that can be used to track progress towards the goal - Each group will report its recommendations to the whole group, answer clarifying questions, and solicit additional input - Groups will create a summary chart(s) of their recommendations - Groups will walk to each chart to review the recommendations and provide closing comments
11:30 AM	Sammye Sigmann	**SUMMARY AND CLOSING** Large group discussion Ask: - *How do you see ACS's ability to impact chemical safety through education programs and resources?* - *What have you heard so far that excites you?* - *What aspects of the work do you want to be a part of?* Describe the next steps: what will be done with the output of this Summit – reporting, follow up, communication, etc.
Noon		**LUNCH AND DEPARTURES**

BUZZ SESSION

Purpose:

In broad terms, these Buzz Sessions are designed to intentionally connect multiple ideas and viewpoints on several topics by engaging participants in several rounds of small-group conversation. This structured process promotes collaborative dialogue and the sharing of diverse perspectives that will ultimately create constructive possibilities for action.

Overview of the Process:

- There will be several rounds of discussion
- During each round:
    - you will work in small groups, 5-8 participants in each
    - in the small group, you will discuss the assigned exploratory topic. All thoughts and perspectives will be captured on chart paper
    - you will move groups for the next session
    - during each session, you will review the existing notes on the topic and add your perspective; creating a cumulative visual memory of the perspectives and ideas shared in each session
- At the end of all sessions, you will return to your original group to synthesize the input provided on that topic, and to craft a summary
- The large group will reconvene to hear the topic summaries, and discuss insights and key themes.

2019 ACS Chemical Safety Education Summit

Introduction

In 2018, the American Chemical Society held its first "safety summit" to develop a strategy for implementing the Society's 2016 recognition of safety as one of its core values. One of the recommendations from the summit was that the ACS be a leader in supporting *"excellent chemical safety education"*. This aligns with the Society's Strategic goal to *"…encourage principles of safety and ethics throughout pre-college, undergraduate, graduate, and post-graduate education."* The summit's report identified seven potential strategies to move towards this safety education goal. These strategies are listed in Table 1.

Table 1: 2018 Summit Education Strategy Proposals

1. Integrate safety into existing ACS education programs.
2. Develop safety specific content that could be integrated into the classroom curricula.
3. Develop a variety of resources using active learning strategies and technology.
4. Develop safety exams and other skill assessment strategies.
5. Establish an ACS awards program recognizing best safety practices.
6. Develop and curate safety information appropriate to teaching laboratories, research activities, and managing laboratory groups and departments.
7. Create partnerships that enable transfer of industrial safety practices to academia so students graduate with industry-ready safety skills.

This year, with the support of the ACS Presidents Peter Dorhout and Bonnie Charpentier, the ACS Safety Summit is convening stakeholders with demonstrated interest in chemical safety education. The goal of the 2019 Summit is to review and build upon the education recommendations identified at the 2018 Summit and propose actionable strategies for ACS and its partners to enhance chemical safety education and safety cultures. The meeting may also identify opportunities besides those proposed in 2018.

The 27 2019 attendees represent diverse levels of experience and professional expertise within the chemistry enterprise. These perspectives include industrial chemists, graduate students, Primarily Undergraduate Institution faculty, Environmental Health and Safety professionals, chemistry education researchers, and representatives of relevant ACS governance units.

The plan of the day and a half meeting is:

1. On Friday morning, March 1, the ACS Presidents will open the meeting by outlining their vision for the meeting. Speakers will then provide thumbnail presentations that describe the 2018 summit and review the draft exploratory questions for the 2019 summit. Attendees will then hear about the diverse catalog of safety and chemical education resources currently available from the ACS. Following this introduction, the whole group will discuss the ideas presented and brainstorm the opportunities they present.
2. On Friday afternoon, small group discussions will discuss the exploratory questions and 2018 proposals in depth so that everyone can share their perspectives on these and learn from other perspectives.
3. At the end of Friday afternoon's discussions, a whole group discussion will identify the five most promising ideas that arose in Friday's discussions for further strategic development on Saturday.
4. On Saturday, small groups will meet to delve into the five most promising ideas and develop a strategic plan to address these opportunities. These strategic plans will: 1) define the project idea as specifically as possible, 2) identify stakeholders who will be involved in addressing this opportunity, and 3) identify SMART goals for assessing the ideas as they are achieved.

Summit Deliverables

1. A summary report to the ACS President, Immediate Past President and 2019 Summit participants.
2. Recommendations to ACS groups and partners to assist with the goals identified during the Summit.
3. Identify external collaborations to advance resource and program opportunities identified during the Summit.
4. Goals for key indicators of success in implementing chemical safety education strategies.
5. A CHED symposium discussing summit results at the San Diego 2019 national meeting.
6. Suggestions for contributions to the upcoming Special Issue of the Journal of Chemical Education on chemical safety education.

Chemical Safety as a Core ACS Value: Report on the 2018 Safety Summit

Introduction

In December 2016, the ACS Board of Directors adopted *safety* as one of the Society's core values, thus affirming that the Society and its members are expected to be leaders in this area. This commitment, which requires a thoughtful and educated approach, recognized that safety is the responsibility of everyone involved in the chemistry enterprise. The practice of chemistry from concept through research, development, manufacture, use, and disposal must include best safety practices in order to minimize individual and public risks while optimizing the societal benefits of the resulting technology.

Recognizing that the Society needs to translate its core value of safety into action, ACS President Peter Dorhout sponsored the first ACS Safety Summit at ACS Headquarters on February 2-4, 2018. He called upon leaders from ACS governance and technical units to help organize the event. External stakeholders representing organizations with expertise and interest in this topic were also identified and invited to participate. Discussion at the Summit centered around four key goals identified by Dr. Dorhout:

1. Identify, connect, and coordinate current ACS efforts and expertise in the area of chemical safety, particularly as it applies to safety culture in academic laboratories.
2. Formulate future ACS strategy to demonstrate the Society's leadership in advancing a culture of safety in the chemical enterprise.
3. Engage ACS stakeholders and external experts in the chemical safety conversation to promote an ethos of safety.
4. Identify tools, opportunities, and partnerships that ACS can leverage to support safety cultures.

Summit participants represented the entire span of the chemical enterprise, including small businesses, national laboratories, government, academia, industry, and non-profit organizations. Representatives from the following ACS groups and partner organizations participated in the Summit:

ACS Groups

- *Chemical & Engineering News*
- Committee on Chemical Safety
- Committee on Professional Training
- Committee on Public Relations & Communications
- Corporation Associates
- Divisional Affairs Committee
- Division of Chemical Education
- Division of Chemical Health & Safety

- Division of Chemical Information
- Graduate Education Advisory Board
- Safety Advisory Panel

Partner Organizations

- American Industrial Hygiene Association
- Association of Public and Land-grant Universities
- Chemical Safety Board
- Dow Chemical Company
- Eastman Chemical Company
- National Institutes of Health
- National Science Foundation
- Oak Ridge National Laboratory
- Pistoia Alliance
- Princeton University
- Texas Tech University
- University of California's Center for Laboratory Safety
- Yale University

Opening Discussions

The Summit started with presentations that provided a broad overview of chemical safety in the context of ACS's past efforts, and a review of key data and research related to safety systems and cultures. The four goals of the ACS strategic plan were presented through the lens of chemical safety:

1. **Provide information solutions**: Connect safety information resources into a flexibly structured ecosystem of ACS and external resources, led by a partnership of ACS and external stakeholders.
2. **Empower members and member communities**: Empower members to become safety leaders as part of their professional and ethical skill set, which are core personal assets.
3. **Support excellence in education**: Develop RAMP-based safety education resources with a focus on building risk assessment skills.
4. **Communicate chemistry's value**: Model safety culture (risk assessment, leadership and empowerment) to the four ACS key audiences.

The National Academies' report *Safe Science: Promoting a Culture of Safety in Academic Chemical Research* provided a foundation for discussions on the challenges encountered when trying to instill a culture of safety across an organization. Interviews engaging approximately 40 individuals in various professional roles conducted by ACS' Web Strategy and Operations group provided additional perspectives on chemical safety. The connection between safety and green chemistry was also noted.

The group shared the experiences of their organizations relative to chemical safety, particularly in the laboratory setting, in order to uncover existing activities and interests in the topic. Participants highlighted current activities, target audiences, existing collaborations, and challenges faced in implementing safety cultures. The conversation addressed how best to align current activities with the goals of the 2018 ACS Strategic Plan, generating ideas for new strategies and identifying opportunities and potential barriers in doing this work. Equipped with this information, participants began identifying actionable strategies and partnerships that ACS can initiate to enhance integration of safety across the chemistry enterprise.

From these broad discussions, a variety of opportunities emerged. These include:

- ACS is leading many efforts and could become a transformative force in integrating safety in all laboratory disciplines, as well as supporting chemical safety information, education, and communication that helps build a robust safety culture.
- ACS volunteers have already created momentum around change and ACS has a significant opportunity to build upon these important past efforts and establish itself as the leader in chemical safety.
- Although many organizations recognize the ACS as a key leader in the laboratory safety world, environmental health and safety professionals do not necessarily consider the ACS their professional home. ACS's focus on chemical safety does address a wide variety of hazards involved in modern laboratory research, which can include biological, radiation, mechanical and novel emerging hazards.
- Within the ACS, safety efforts are currently concentrated within a few specialized groups (primarily the Division of Chemical Health and Safety and the Committee on Chemical Safety), but safety should be integrated in all ACS programs and divisions.
- ACS messages related to safety are often in response to negative situations, such as reports about accidents, which indicate a lack of safety**.** By connecting effective safety practices and cultures to scientific success, the ACS can communicate the powerful message that good science is safe science.

Identification of Action Steps

During the second day of the Summit, the group narrowed its discussion to assess a variety of actionable strategies organized around the four ACS strategic goals.

Goal 1: Provide Information Solutions

Safety Strategy: **Information/Research Support**: **ACS should leverage its current resources to become the authoritative laboratory chemical safety information source.**

The ACS prides itself on being the preeminent source of chemical information and boasts the oldest and most comprehensive chemical information abstracting service. Like other chemical information, chemical safety information is widely dispersed and can be difficult to find or access. Under the provisions of the OSHA Hazard Communication Standard, employers are responsible for informing employees of the hazards and the identities of workplace chemicals.

ACS should create partner networks to connect these diverse sources into a range of useful, searchable and authoritative information sources. For example, some ACS members are primarily interested in raw data for experimental planning purposes, while others are primarily interested in best practices associated with managing safety in teaching labs. Chemists in both academia and industry are generating safety content, and ACS can collate and curate this information into a comprehensive, authoritative resource.

The following specific strategies were identified:

- Identify gaps in chemical information
- Connect, organize, disseminate and make available a variety of chemical safety information types (host, index, etc.) in an easily searchable way.
- Develop a platform that makes lessons learned, near misses, incident reports, and case studies readily available to the chemistry community.
- Collect safety moments, which can be peer-reviewed and indexed, from the communities around the ACS to help reinforce a culture of safety.
- Create a searchable collection of safety moments for use in technical gatherings.
- Provide free copies of the *Journal of Chemical Health and Safety* to all chemistry departments.
- Establish a clearinghouse of laboratory chemical safety experts, who could respond to safety questions or recommend consultants for more complex questions, as an ACS service to the community.

The suggested partners to work with in advancing this goal include: the Division of Chemical Health and Safety, Committee on Chemical Safety, *C&EN* staff, Chemical Abstracts Service, ACS Publications, ACS Division of Chemical Information, ACS Education Division, ACS Web Strategy and Operations, the Pistoia Alliance, the University of California Center for Laboratory Safety (UCCLS), Campus Safety Health and Environmental Management Association (CSHEMA), American Industrial Hygiene Association, Stanford University, and the National Library of Medicine.

Goal 2: Empower Members and Member Communities
Safety Strategy: Partnerships/Communities. ACS should create strategic partnerships and communities across disciplines to empower chemistry practitioners through development of chemical safety skills.

The distinction between creating partnerships and communities around chemical laboratory safety and laboratory chemical safety was articulated. This distinction suggested that ACS might consider becoming a Center for Laboratory Chemical Safety and reach out to engineers, biologists, medical scientists, etc. about the safe use of chemicals in laboratory settings. This approach was strongly supported by the NIH representative who suggested that much of the research conducted at the NIH would not qualify as chemistry research, but because

researchers work with a variety of chemicals, they must have access to chemical safety information and best practices.

The following specific strategies were recommended:

- Identify strategic partners to support goals for an ACS Center for Laboratory Chemical Safety and formalize them through Memoranda of Understanding.
- Convene a Safety Summit for these partners to discuss the possible synergies and areas for collaborations.
- Lead an effort for Federal funding agencies to require safety information on all research proposals.
- Create online platforms and workshops for sharing best practices and enabling continuous dialogue about safety. (see bullet 2 under Goal #1)
- Regularly bring together members from different parts of the ACS (students, faculty, environmental health and safety experts, and industrial members) to create chemical safety learning communities.

The suggested partners for advancing this goal include the Division of Chemical Health and Safety, Committee on Chemical Safety, University of California Center for Laboratory Safety (UCCLS), Campus Safety Health and Environmental Management Association (CSHEMA), Chemical Safety Board, National Science Foundation, Oak Ridge National Laboratory, National Institutes of Health, Yale University, Princeton University, Texas Tech University, Association of Public and Land-grant Universities, American Institute of Chemical Engineers Center for Chemical Process Safety, the Dow Chemical Company, and other universities with strong safety cultures.

Goal 3. Support Excellence in Education
Safety Strategy: Education/Empowerment. ACS should support excellence in safety education by creating and disseminating safety content that would enable integrating safety knowledge throughout the entire chemistry curriculum.

Laboratory safety involves the development of specialized knowledge, skills and responsibility and must be an integral part of the chemistry curriculum. This means that safety education and awareness must be integrated into each laboratory course as well as into academic research laboratories, with increasingly broader scope at more advanced levels.

The following specific strategies were identified:

- Integrate safety into existing ACS education programs, such as workshops for new faculty, public outreach activities, Student Chapters, and High School Chemistry Clubs.
- Develop safety specific content that could be integrated into the classroom curricula and connected to the Next Generation Science Standards. (http://www.nextgenscience.org)

- Develop a variety of resources using active learning strategies and technology (workshops, multimedia, online learning, flipped classrooms, etc.)
- Develop safety exams and other skill assessment strategies.
- Establish an effective ACS awards program recognizing the best safety practices in ACS programs and educational activities.
- Develop and curate safety information appropriate to teaching laboratories, research activities, and managing laboratory groups and departments. (see bullets 2-5, Goal #1)
- Create partnerships that enable transfer of industrial safety practices to academia so students graduate with a safety mindset and safety skills, making them ready for industrial employment.

The suggested partners to advance this goal include CCS Safety Education Subcommittee, Society Committee on Education, Committee on Professional Training, Corporation Associates, ACS Education Division, ACS Division of Chemical Education, American Association of Chemistry Teachers, National Science Teachers Association, and the Dow Chemical Company.

Goal 4: Communicate Chemistry's Value

Safety Strategy: Communication*.* Develop and execute a progressive safety communication strategy and associated plan that establishes ACS as the authority for laboratory chemical safety.

These specific short-, mid- and long-term strategies have been identified:

- Define how safety as a core value connects to professionalism and ethics and establish a public platform for explaining these principles to a variety of audiences.
- Develop a communication plan that defines messaging applicable to targeted audiences, along with methods for measuring effectiveness. For example, this could be done through an ACS-wide contest to increase visibility and maximize engagement.
- Develop messaging to make safety visible throughout the Society. Elements of these messages may include:
  - Create a brand and tagline.
  - Develop a template with safety moments and promote its use during all programs at the ACS national and regional meetings.
  - Equip the ACS Mole mascot with a safety message (beyond goggles and lab coat) that can be shared at national and regional meetings and other public events.
  - Promote existing ACS safety resources through the ACS Safety Website and a variety of other activities.
  - Develop talking points that enable Society leaders to advocate "safety as a core value".
- Develop safety leadership training to be included as part of ACS's Leadership Development Program.

The Committee on Chemical Safety has a Communication Safety Subcommittee, which can contribute its leadership and expertise to these strategies.

In summary, the Summit provided a valuable opportunity for stakeholders, both internal and external to ACS, to share information, resources, and initiatives in order to identify opportunities to enhance safety across the chemistry enterprise. Moving these ideas forward will involve new partnerships within ACS and with external partners. As they are implemented, the ideas generated during the Summit will help guide the Society's future strategy on chemical safety and further ACS's vision of *"Chemistry for Life"*.

Exploratory Questions for 2019 ACS Safety Education Summit

To provide a starting point for the discussions, the Planning Committee has drafted four exploratory questions for the Summit to consider. These questions are based on ongoing discussions within various ACS groups around the key challenges of chemical safety education. These questions may be modified in the course of the Summit discussions. The draft questions are:

- What expectations do employers of chemists in various sectors (industry, academia, and government) have for the safety competencies (in terms of safety knowledge, skills, and attitudes - KSAs) of the chemists they hire?
- What emerging safety KSAs do chemistry educators believe should be included in a 21st Century chemistry education? Such KSA's can involve technical topics (such as green chemistry principles, chemical information skills, or knowledge of regulatory requirements) or professional skills (such as development of safety cultures, ethical expectations, and interdisciplinary teamwork).
- What are the differences between safety training and education, and how do each of these approaches support the development of the safety KSAs chemists are expected to have?
- Within the current chemistry curriculum, how and where are chemists best educated in a safety culture ethos?

The fifth topic to be discussed on Friday afternoon will be to review and prioritize the safety education recommendations from 2018 with regard to their feasibility and value.

ACS Education Division Programs and Resources with Safety Components

Guidelines (overarching frameworks for organizations to use to build a safety foundation and culture)

- NCW and Community Activity Safety Guidelines
- *ACS Guidelines and Recommendations for Teaching Middle and High School Chemistry (2018)*
- *ACS Guidelines for Chemistry in Two-Year College Programs (2015)*
- *ACS Guidelines and Evaluation Procedures for Bachelor's Degree Programs (2015)*
- *Laboratory Safety (2017)*
- ACS Student Chapter Report Review Criteria and Considerations

Training (activities to prepare educators and learners to use tools and practice safety, building a safety foundation)

- ACS Festival Training Institutes
- US National Chemistry Olympiad study camp
- AACT Webinars
- *Chemistry in the Community* Webinars
- *Chemistry in Context* Workshops
- Safety sessions at New Faculty Workshops
- ACS Professional Education courses

Tools (resources for demos, classroom activities, and events that develop safety awareness and knowledge)

- *Celebrating Chemistry* (Milli's Safety Tips (2007), activity safety tips)
- Volunteer tool-kit for science outreach (under development)
- AACT Safety Statement
- AACT Safety Contracts (Grades K-1, Grade 2-5)
- AACT Disposal Quick Reference Guide
- K-8 Hands-on Activities safety tips and notes
- ChemClub Laboratory Safety Agreement
- ChemClub Resource packets safety tips
- ChemDemo Exchange safety guidelines
- *Chemistry in Context*, 9th Edition, and lab manual
- *Chemistry in the Community*, 6th Edition (includes lab curriculum)

Information (introduction to safety concepts, tools, skills, and careers that develop safety awareness and knowledge)

- *Chemistry Solutions* (AACT) articles
- *ChemMatters* (high school) articles
- *inChemistry* (ACS Student Member Magazine) articles
- College to Career website
- ChemIDP online career planning tool
- "Developing Skills" in *Planning for Graduate Work*
- *Committee on Professional Training Newsletter* articles

Chemical Safety Education Resources from ACS Communities

No.	Title	Intended Audience	Publishing Group	Last Updated
1	***Guidelines for Chemical Laboratory Safety in Secondary Schools***	high school educators	ACS CCS	2016
This publication includes 53 learning outcomes for students and clear, concise explanations for teachers on select safety topics including basic safety information, RAMP, GHS, Fire Safety, NFPA, hazardous waste, and SDSs.				
2	***ACS Guidelines and Recommendations for Teaching Middle and High School Chemistry***	middle and high school educators	SOCED	2018
Laboratory safety is included extensively in these Guidelines with information on safety equipment and references as well as a discussion of "RAMP" principles. Revised in 2018.				
3	***Better Rainbow Demonstration*** *and High School Safety outreach videos*	high school students and educators	ACS Education and Scientific Advancement Divisions	2016; forthcoming
The videos introduce chemical safety to the high school students and provide additional overview of some issues related to the safe use of chemicals in the high school environment.				
4	***ACS Guidelines for Chemistry in Two-Year College Programs***	two-year colleges educators	SOCED	2015
In addition to sections on Safety Culture and Laboratory Safety, the development of a safety culture in the institution is woven throughout the *Guidelines.*				
5	***Guidelines for Chemical Laboratory Safety in Academic Institutions***	undergraduate-graduate educators	CCS	2016
This publication presents 104 chemical safety learning objectives for undergraduate curriculum designers and instructors and outlines how learning should progress into graduate education based on RAMP. Published in 2016.				
6	**ACS Approval Program for Bachelor's Degree Programs** includes the Guidelines and supplements to the Guidelines.	undergraduate educators	CPT	2015 and 2017
The Guidelines represent the requirements for a department to offer an approved bachelor's degree program, and the characteristics of that program, including a mandatory safety skills requirement for the department to follow, and the students to learn about. The Safety Supplement to ACS Guidelines: describes in further detail the aspects of safety development that a program must implement, and for the students to understand as part of their education in chemistry.				

7	***Safety in Academic Chemistry Laboratories***	first- and second-year undergraduate students	CCS	2018
This 8th Edition of the CCS flagship publication Introduces RAMP and communicates practical laboratory safety information to first- and second-year undergraduate students. Includes Arabic translation.				
8	***Chemical Health and Safety Exam (or ACS Exams Institute Draft Safety Exam).***	undergraduate educators	ACS Exams Institute	Forthcoming
Currently (spring 2019) in trial testing, this 60 item multiple choice exam is designed to address safety topics typically addressed during the first two years of undergraduate chemistry coursework.				
9	***Teaching Chemical Safety and Information Skills Using Risk Assessment*** (Chapter 3) in *Integrating Information Literacy into the Chemistry Curriculum*	undergraduate educators	ACS Symposium Series	2016
This chapter demonstrates how risk assessment (JHAs) can be used to teach information skills and safety competencies by providing rationale and examples (including assessment data) which can be incorporated into undergraduate learning..				
10	***Identifying and Evaluating Hazards in Research Laboratories* publication and *website***	undergraduate and graduate researchers	CCS	2014
This online reference presents a detailed introduction to the academic research community on risk assessment and provides practical examples using five techniques: Control Banding, Job Hazard Analysis, What-if, Checklists, and SOPs.				
11	***Risk Assessment video***.		CHAS	2018
Emphasizes importance of conducting a risk assessment of laboratory work and maintaining situational awareness as laboratory work proceeds.				
12	***Graduate Student Workshops***	graduate students and faculty	CHAS	ongoing
A three-hour workshop for graduate students and faculty about developing and maintaining laboratory safety programs in the research setting. Offered at the ACS National Meeting. Started in 2018 and ongoing.				
13	***Accessibility in the Laboratory***	all levels of education	ACS Symposium Series	2018
A valuable update to the 2001 4th edition of "*Teaching Chemistry to Students with Disabilities: A Manual for High Schools, Colleges, and Graduate Programs*", this symposium book integrates safety into broader best practice discussions for students with a range of				

accessibility issues, including topics such as visual and hearing impairments, invisible and physical disabilities, service dogs, and more.				
14	***ACS Style Guide Safety Chapter*** Forthcoming.	authors and reviewers	ACS Pubs	Forthcoming
The 2019 Edition of the ACS Style Guide will include, for the first time, a chapter designed to provide guidance for authors and reviewers on how to prepare and include publication appropriate safety summaries in manuscripts.				
15	**CHED Demonstration Guidelines**	educators and students. All levels.	CHED	2016
A concise set of guidelines to aid experienced chemical practitioners in considering all components of demonstrations, including special notes for transportation and communication as well as best practices before and during a chemical demonstration.				
16	***Journal of Chemical Health and Safety***	safety professionals	CHAS	ongoing
JCHAS is a peer-reviewed journal that addresses chemical safety education topics among other topics chemical safety professionals are involved				
17	***The DCHAS-L e-mail list***	CHAS members	CHAS	ongoing
The list is available to members of the Division and provides an active discussion of technical and cultural issues faced in improving safety practices in all workplaces, with an emphasis on labs				
18	***CHAS Professional Development Workshops***	safety professionals	CHAS	ongoing
Daylong workshops for chemical safety professionals at national and regional meetings covering regulatory and technical topics.				
19	***C&EN SafetyZone blog and safety articles***	Chemical community	ACS Publications	ongoing
Ongoing coverage of chemical safety related news items				

Other Key Chemical Safety Education Resources

1	**Finster, D.; Hill. R. *Laboratory Safety for Chemistry Students*; Wiley 2010 and 2016** Laboratory and chemical hazards, routes of exposure, ways to manage these hazards, and handling common laboratory emergencies are covered. Emphasis on the ability to safely use hazardous chemicals in the laboratory by applying safety principles that prevent and minimize exposures.
2	***Prudent Practices*, National Academies Press, 2011** An authoritative reference on the handling and disposal of chemicals at the laboratory level. The revised edition has an expanded chapter on chemical management includes nanotechnology, laboratory security, and emergency planning.
3	***Safe Science*, National Academies Press, 2014** Examines the culture of safety in research institutions and makes recommendations for university leadership, laboratory researchers, and environmental health and safety professionals to support safety as a core value of their institutions.
4	**Guide to Implementing Safety Culture, APLU, 2016** Roadmap for a university-wide effort to strengthen a culture of research safety. The guide has action steps, resources, and recommendations to help navigate the challenge of changing the culture of the institution. Includes reading lists, tools, strategies, illustrative examples, and/or best practices.
5	***Inquiring Safely* series, NSTA, 2003** Introduction of General Safety in the classroom for varying levels of education. Encourages safety within a climate of inquiry incorporates inclusion adjustments. Responsibility guidelines included.
6	**Flinn High School Safety products**, Flinn Scientific A variety of products and resources related to chemical safety for teachers. Product site that may be filtered by education level.
7	**Safety Videos library, Dow Chemicals, 2014** Videos that cover industrial safety culture and practices for laboratory safety. Each module covers information that has worked successfully at Dow. It includes basic explanations of the topics and relates them to safety. Dow's granted ACS an opportunity to use the videos in its upcoming e-learning safety course.
8	**Green Chemistry education web page, ACS Green Chemistry Institute** Resources and programs give students and educators the opportunity to learn the chemistry concepts and skills that embrace life cycle thinking and provide a foundation for contributing to a sustainable future through chemistry.
9	**Case studies and videos, Chemical Safety Board** Videos describing lessons from significant safety incidents, including academic and high school laboratories.