Cynthia J. Burrows
Distinguished Professor
of Chemistry

THE UNIVERSITY OF UTAH

Phone: (801) 585-7290
Fax: (801) 585-0024
Email: burrows@chem.utah.edu

May 26, 2010

Dr. Iain M. Johnstone
Department of Statistics
Stanford University
450 Serra Mall
Stanford, CA 94305-2070

Dear Iain,

Enclosed please find the report of the Committee of Visitors to the Chemistry Division, which met from May 3-5, 2010. The report includes:

- The general conclusions and recommendations of the committee
- A summary of the specific findings of the COV concerning the review process, the outcomes of CHE's investments, and the response of CHE to the 2007 COV report
- The membership of the 2010 COV
- The charge to the COV from Dr. Ed Seidel
- Individual reports from seven subpanels
- Responses to template questions

The COV concluded that outstanding science is being funded through this program, and that the scientific staff of CHE are demonstrating excellence in management of this diverse portfolio.

On behalf of the COV,

Sincerely,

Cynthia J. Burrows
Distinguished Professor
Chair, 2010 COV for CHE

Department of Chemistry
315 South 1400 East
Salt Lake City, Utah 84112

Report of the Committee of Visitors
Division of Chemistry
National Science Foundation
May 3-5, 2010

I. Background

The Committee of Visitors for the Division of Chemistry (CHE) met for three days to review the activities of the Division during the three-year period 2007-2009. The original meeting dates of February 9-11, 2010 were rescheduled due to a snowstorm in the Washington, DC area. Nearly 80% of the original COV members were able to attend the rescheduled meeting, but additional members were sought to cover a diversity of scientific, geographic, institutional and demographic characteristics. Appendix A is a list of the membership of the committee whose 33 members include five members of the National Academy of Sciences, a large number of national award winners in chemistry and related fields, and leaders in the chemical enterprise from industry, national agencies, and academe.

The COV was charged to address and prepare a report on:
(a) the integrity and efficacy of processes used to solicit, review, recommend, and document proposal actions;
(b) the quality and significance of the results of the Division's programmatic investments;
(c) the relationship between award decisions, program goals, and Foundation-wide programs and strategic goals;
(d) the Division's balance, priorities, and future directions;
(e) the Division's response to the prior COV report of 2007; and
(f) any other issues that the COV feels are relevant to the review.

Prior to the meeting of the COV, members were given access to a number of documents on the NSF CHE website: http://www.nsf.gov/events/event_summ.jsp?cntn_id=116169&org=CHE
These documents provided the 2007 COV report and the CHE responses to it over the 3-year period, the recently developed CHE Strategic Directions document, information about the merit review process, and key statistics on CHE funding as well as highlights of outcomes of CHE funded programs.

The meeting of the COV began on May 3rd with the charge to the COV from Dr. Ed Seidel, Acting Assistant Director of the Math and Physical Sciences Directorate; the letter stating the formal charge appears in Appendix B of this report. Dr. Seidel's remarks were followed by a briefing on conflicts of interest by Dr. Morris Aizenman, Senior Science Associate for MPS. Dr. Luis Echegoyen, Division Director of CHE for the past four years, then presented an overview of the activities of CHE over the three-year period. This was followed by a discussion of general procedures for the COV review process led by Dr. Katharine Covert, Acting Executive Officer of CHE.

For the remaining part of the first day, the COV members separated into seven subpanels representing the programmatic areas of CHE:

- ASC: Analytical and Surface Chemistry
- IBO: Inorganic, Bioinorganic and Organometallic Chemistry
- OMC: Organic and Macromolecular Chemistry
- PChem: Experimental and Theoretical Physical Chemistry
- Education: Research Experiences for Undergraduates (REU) and American Competitiveness in Chemistry-Fellowship (ACC-F)
- Infrastructure: Chemistry Research Instrumentation and Facilities (CRIF-MU and MRI)
- Centers: Centers for Chemical Innovation (CCI)

The individual subpanels were first briefed by a program officer (PO) in the area before beginning the review of a selected number of proposal "ejackets" for the 2007-2009 fiscal year funding period. Ejackets were selected to represent some number of clearly fundable cases, some clear declinations, and a larger fraction of borderline cases. Many of the subpanels also requested additional ejackets for review, and these were promptly provided following a review for conflicts of interest. At the end of the day, each subpanel prepared a report addressing the Section A questions of the COV Report Template.

Whereas COV members were assigned to subpanels on the first day according to their primary affiliation with a subdiscipline of chemistry, the members spent the morning of the second day in a different subpanel performing a "cross-read" review. The new subpanels prepared their second round reports, and the early afternoon was spent preparing merged reports by the combined membership of the first and second round subpanels. The membership of the subpanels and the complete agenda for the meeting is found in Appendix C. The final merged reports for each of the subpanels are included in Appendix D.

The remainder of the second day was spent in discussions of the Section B questions of the report which focus on outcomes of the CHE investment in three areas, Discovery, Learning and Research Infrastructure. The committee approached this by again dividing into smaller groups for the purpose of facilitating discussion. For the first hour, four subgroups of eight members each focused their attention on "Discovery" aspects by examining highlights, press releases and other materials available on the CHE website. The highlights and related materials came primarily from the Individual Investigator Awards portfolio of CHE, which comprises about 75% of the CHE budget, in addition to Center awards. At the end of the hour, the session chairs met to write a combined report. Meanwhile, two subgroups each met simultaneously on the topics of "Learning" and "Research Infrastructure." Outcomes on "Learning" were gleaned from the wide array of domestic and international REU programs; outcomes on "Research Infrastructure" were evaluated on the basis of highlighted awards in shared instrumentation grants and related facilities. The respective session chairs then collaborated to write joint reports. A summary of their reports appears in the answers to Section B questions in Appendix D. Other details assembled by these subcommittees are found in section III.B below.

The third day of review, May 5th, started with a brief discussion of the Section B Outcomes reports, followed by a more general discussion of issues pertinent to the Division. This part of the discussion used the Section C questions, amended by the COV Chair, as an outline for discussion. The morning session was conducted as a closed session with only the COV members present in the room in order to encourage frank discussion between members. Conversely, all CHE staff members were invited to the afternoon session during which the COV presented their findings to Dr. Ed Seidel.

The COV members wish to commend the CHE staff for their highly professional organization of meeting materials and very helpful presentations and discussions throughout the process. The Program Officers, Executive Officers, and Division Director were immediately available to the COV for questions, helpful suggestions, and explanations of the many difficult decisions made over the course of three years. Their open and friendly attitudes accelerated the COV review process and continue to add to the effectiveness of the CHE program overall. Special thanks are due to Acting Executive Officer Katharine Covert for her extraordinary devotion to the COV review process over a period of nine months, and to Janice Hicks, Acting Executive Officer of DMR, for advice and assistance.

II. General Conclusions and Recommendations

Chemistry, the "Central Science," is a core discipline that brings molecular understanding to the world around us and builds bridges to Physics, Biology, Materials Science, and Engineering. Chemistry enables new discoveries that fuel the U. S. economy through contributions to medicine, energy, electronics, and national defense. The U. S. boasts a vibrant community of chemists whose seminal discoveries are supported by the National Science Foundation. Yet, a 2007 report from the National Academy of Science entitled "The Future of U. S. Chemistry Research: Benchmarks and Challenges" concluded that America's competitive edge in the chemical sciences hangs in the balance.[1] Although chemistry research is stronger in the U. S. today than in any other single country, competition from Europe and Asia is rapidly increasing. The report pointed to three major concerns for the near future: (1) that U. S. chemistry research will diminish in *core areas*, (2) that a sustainable *supply of U. S. chemists* may be in jeopardy, and (3) that U. S. *funding for research and infrastructure* will remain under stress. **The NSF Division of Chemistry is our nation's most critical player in addressing these three concerns.**

Within this context, the COV was pleased to note that the CHE budget had increased at a higher than average rate over the past three years, but it is still lower than the other four disciplines in MPS. Much of the increase was directed to the creation of Centers for Chemical Innovation (CCIs), but the budget for individual investigator awards (IIAs), which includes small collaborations, has also grown modestly.

The COV recommends that CHE senior staff members continue to stress the importance of investing in Chemistry as a core discipline by highlighting major accomplishments resulting from CHE investments. The previous support of a half-time science writer for press releases was viewed positively, and this, or a related mechanism, should be explored.

Centers for Chemical Innovation have grown substantially over the past three years both in number and as a proportion of the budget. The CCIs were praised as a mechanism for tackling Grand Challenges, both in the core of the discipline as well as for exploration of emerging interdisciplinary areas. At the same time, there is mounting concern in the chemistry community that the funding of Centers is done at the expense of the Individual Investigator program. Although the actual data suggests that both CCI and IIA budgets are growing, it is important to the long-term health of the field of Chemistry that the individual investigator and small-team collaborative programs constitute a large and thriving fraction of the funded portfolio.

The COV recommends that the IIA research project budget continue to grow at a rate that ensures a high level of productivity from the best laboratories across the U. S. The Division should encourage the growth of Centers as funds become available without compromising the IIA budget. The Division Director should be commended for his efforts to disseminate information about the NSF budget to the broader community via such mechanisms as the Town Hall gatherings at ACS national meetings, and these efforts need to be continued.

One member of the COV described her NSF funds as "small, but precious!" NSF grants are viewed as more flexible in terms of scientific direction because they are used for basic research rather than mission-oriented studies. Thus, NSF investments can have a major impact on transformative research by being leveraged as an early investment in bold new directions. However, the grant sizes are simply too small. Currently, the average budget size of individual investigator awards in CHE is sufficient to support 1.5 coworkers in the principal investigator's laboratory plus laboratory supplies, minor equipment, and one month of the PI's summer salary.

[1] The Future of U. S. Chemistry Research: Benchmarks and Challenges, National Academies Press: Washington, DC, 2007

One consequence of the small grant size is that some of the best and brightest researchers do not even apply to NSF for funding but direct their work instead toward applications-oriented agencies that have larger award sizes. As a result, NSF may be missing opportunities to fund transformative research in basic chemical sciences, and to invest in laboratories where NSF funds can be leveraged to spawn bold new programs.

The COV recommends that CHE place a priority on growing the size of the average IIA toward $200K per year (from the current $144), despite the fact that this might lead to a lower success rate initially. Like other members of the community, the COV members are encouraged by the efforts to double the NSF budget in the next 10 years, and it is hoped that this growth will permit increased grant sizes without decreasing the number of individual grants in the portfolio.

CHE invests a substantial fraction of its budget in new investigators, many of them via the CAREER program, and the COV is fully supportive of this approach. However, there is less data on the success rates of PIs across the various career stages from post-tenure to mid-career to senior investigator status.

The COV recommends that the success rate of applications be monitored across different career stages for PIs to ensure that we do not lose more seasoned, yet highly productive and innovative investigators from the long-term pipeline.

CHE Program Officers are doing an excellent job of managing the merit review process in a timely fashion given limited resources. However, there is strong concern that the peer review process is not sustainable under the current restraints. The response rate of ad hoc reviewers is low, and frequently their comments are brief or merely summarize the research without evaluating it. Panels have been added as an evaluative procedure that works well in some areas, but not as well in those disciplines that are too broadly defined and where very specific expertise is required.

The COV recommends that CHE explore additional mechanisms for review that might increase the efficacy of the process and increase the scientific value of the reviews. Ideas might include (1) use of cyberconferencing and panels outside of Washington to lower costs and relieve travel time for reviewers, (2) inform ad hoc reviewers that their reviews will be read by a panel, (3) develop a more robust database for searching, assigning and tracking reviewers, including opt-in/opt-out responses similar to journals, and (4) hire more program officers! The COV noted that NIH has undergone substantial changes to their application and review processes over the past two years as a result of a systemwide study. Some of the lessons learned at other agencies might be useful to NSF staff in this regard.

Applicants and reviewers continue to struggle with the Broader Impacts criterion, and the COV discussed this issue in some detail. Years after implementation, the community remains confused about what constitutes Broader Impacts and how this criterion is weighted during the review process. This is despite the fact that broader impacts have been discussed at Town Hall meetings for more than 5 years, that Dear Colleague letters have been sent repeatedly, and that the CHE website has an excellent link on its homepage describing broader impacts: http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13626&org=CHE&from=home. Clearly, no single definition of broader impacts is appropriate, nor can a weighting scheme be devised that fits every program, but the apparent subjectivity of broader impacts is still cause for concern in the minds of applicants and reviewers.

The COV recommends that CHE continue to educate the community through the current mechanisms, but also explore other ways in which PIs and reviewers can be informed about best practices in terms of Broader Impacts. It is important for NSF to work to clarify the intent and meaning of the criterion. Ideas might include (1) sending the Broader Impacts web link shown above to reviewers, or (2) developing a

voluntary on-line tutorial for PIs and reviewers. In addition, program officers should continue to work together to form a consensus for those borderline applications where intellectual merit and broader impacts appear to be valued differently by the reviewers. POs need to be clear in documenting declinations about how the reviews of the two merit criteria led to the decision that was made.

Furthermore, *the COV recommends* that a study by CHE to assess the proposal use of and reviewer evaluation of broader impacts be implemented in order to provide feedback on this challenging problem. Such a project was initiated by CHE already, but the company conducting the study folded and conclusions could not be reached.

One outcome of the 2007 COV report was the recommendation that CHE develop a strategic plan. CHE did this, with input from program officers and the community, resulting in a Strategic Directions document that has helped guide the division toward their short and long-term goals. A major part of the plan was to realign the structure of the division, dispensing with the classical terms organic, inorganic, physical and analytical, in favor of more modern, interdisciplinary descriptors of chemical sciences. The COV commends the division for taking these bold steps; however, it is too early to tell how well the new system is working. The FY 2007-2009 actions reviewed by this COV were essentially all performed under the prior system.

The COV recommends that the division (1) reassess and update the Strategic Directions document periodically, (2) evaluate and refine the new interdisciplinary programs as needed, and (3) continue to educate the community about the new programs, for example, by broader distribution of the new brochures that describe the realignment.

Finally, the COV wishes to commend the Chemistry Division for their skillful handling of ARRA support during the past year. These funds were a welcome addition to the chemistry community, but placed an enormous burden on the program officers to handle additional requests and to reevaluate earlier decisions. The COV supports the managerial decision to increase substantially the funding of shared instrumentation and facilities because these funds are then broadly distributed to institutions. As one-time funds, they should not result in a 3-year "bubble" of renewal applications. Furthermore, these instruments typically have a ~15 year lifespan, and therefore the impact will be far reaching. ARRA funds were also used to significantly increase the number of CAREER awards and to provide funding to certain borderline applications that, while adding an element of risk to the portfolio, may also result in more transformative results in the long term.

III. Specific Results of the Review

A. Integrity and Efficacy of the Review Process

A.1 Quality and Effectiveness of Merit Review

Most applications to CHE are merit reviewed on an ad hoc basis by scientists identified as experts in the field, although there has been an increasing reliance on panels to supplement the review process. We found that the combination of ad hoc and panel review was, for the most part, being appropriately implemented by the program officers. In some fields (organic synthesis, for example), panels were found to be an excellent way of reaching a consensus about the importance of the science. In others (PChem, for example), concern was expressed that panels could not fully represent the breadth of expertise needed to appreciate some specialized areas of chemistry. For instrumentation and REU proposals, the review process is very appropriate. Overall, the POs seem to be reaching the proper equilibrium of ad hoc and panel reviews, and it is appropriate that this mixture be different for the different programs. The COV wishes to stress the importance of carefully selecting panel members for their scientific expertise. Center

proposals were also reviewed via site visits in some cases, which is highly appropriate given their expanded functions.

In many cases examined, both review criteria (intellectual merit and broader impacts) are being addressed in the review process, but this is by no means always the case. The greatest variability is seen with ad hoc reviewers in evaluating broader impacts, and often the reviewer simply restated what the PI plans to do rather than providing an assessment. On the other hand, it was felt that panel reviews often provided a better consensus on broader impacts. Among programs, review of REU proposals was perhaps most problematic where reviewers had difficulty in addressing both criteria in a substantive way. Generally, POs do a good job of addressing both criteria. The recently introduced "PO Comments" are working very well at providing feedback to declined proposals, but there is still room for improvement to better inform PIs about how the two merit criteria are being weighted in arriving at a funding decision. There appear to be a few cases where the broader impacts criterion overrode a panel's recommendation.

In the disciplinary programs of CHE, many of the reviewers provide detailed and conscientious assessment of the work proposed. However, there remains a substantial fraction of the ad hoc reviews that are cursory without providing enough justification for their rankings. The work then falls to the panel (if there is one) and ultimately to the PO to weigh the comments of the substantive reviewers accordingly. Obviously, encouraging more thorough and substantive reviews would lessen the burden on POs. Although panels are more likely to reach a consensus, the written reports from panels usually summarized the conclusions of the ad hoc reviewers. In those cases where they differed, some additional comments on why the panel reached a different conclusion would be helpful. Panelists can change their rankings during the review process, and they should also be encouraged to update their comments to reflect any changes in rankings made during the panel meeting.

Program officers wrote review analyses that generally provided an excellent summary of the reasons for which a funding decision was made. Occasionally, the PO analysis was different from the panel summary, and in those cases, it is particularly important to provide extensive feedback to the PI. The recent implementation of "PO Comments" appears to be helping with this process and its continued implementation is highly encouraged.

The program solicitation for the CRIF-MU proposals requires a Departmental Plan for Broadening Participation, and it is the only program in the CHE that does so, because the proposals generally come from a department chair rather than a single PI's laboratory. At present, reviewers are asked to comment on how the new instrument would facilitate the department's plan for broadening participation. Although it is recognized why CHE chose this program as a place to ask for the plan, it is not clear that the instrument itself is the right match as a mechanism for broadening participation.

Another suggestion that arose during the course of CRIF-MU review was the inability to assess the diversity of PIs applying to the program due to the fact that the PI is by default the departmental chair. Would it be possible to require the person who actually wrote the proposal to be listed as a coPI, particularly in those cases where the PI is not a major user? This would give credit to the efforts of a likely more junior faculty member, who is possibly a member of an underrepresented group.

In general, the POs are doing an outstanding job of making difficult decisions for applications at the borderline. The process generally goes beyond a single PO, and involves a group of POs reaching a consensus on an application. For those isolated cases in which a PO decision was inconsistent with the consensus, we recommend that the POs reconvene to discuss an application before a recommendation is reversed.

Program officers are to be complimented for their timely processing of applications for most programs. The major exception to this statement is the case of ARRA funding decisions in 2009 which placed an unusual burden on the workload of POs. The reversals of decision made under ARRA funding were, for the vast majority of cases, highly appropriate.

A.2 Selection of Reviewers

The COV found that POs are doing an excellent job of identifying reviewers of the appropriate expertise and with a good balance of geographical and institutional characteristics, at least among academic reviewers. Several programs noted that greater use of industrial and national laboratory scientists could be made, and this might help alleviate the problem of lack of response from a large fraction of academic reviewers. In particular, it was noted that the more senior members of the community were less participatory in the review process. It was difficult to determine if reviewers from under-represented groups were being included from the data provided. In a few cases, the balance of geographic or institutional parameters needed adjustment. For example, panels reviewing CRIF-MU proposal should include some reviewers from Research I institutions, and panels within the disciplines should include members very carefully selected for their scientific expertise. Conflicts of interest were being handled appropriately by the POs.

A.3 Resulting Portfolio

The proposals being funded by CHE are deemed to be of high quality and at the leading edge of chemistry disciplines. The research portfolio has the potential to greatly impact several of the MPS Grand Challenges. The programs support research directed at a wide range of crucial national priorities including energy, medicine, materials and the environment. Regrettably, much excellent science remains unfunded or underfunded, and the COV looks forward to a budget doubling at NSF to help ameliorate this situation.

The majority of CHE grantees are members of chemistry departments across the U.S., and as such, each participates in a balance of teaching and research activities. Integrating research with undergraduate, graduate and postdoctoral education lies at the heart of preparing the nation's next generation of scientists. Academic chemists are extremely well positioned to excel at this endeavor.

There was a consensus among COV members that the award size and duration is too small! Small awards tend to favor conservative research and limit efforts to conduct high risk, transformative research. At Research I institutions, grant size should be increased making it possible to fund 2 coworkers on average instead of 1.5. At PUIs, it may be more effective to have longer duration awards to provide more continuity to the researcher and lessen the burden on reviewers.

Most programs were found to have an appropriate mix of multidisciplinary science, and the POs have demonstrated willingness to encourage investigators in new areas and those willing to take risks. However, funding for outstanding research in the core of the discipline is essential, because many major advances come from long-term scholarly and thorough investigations. This type of research should remain as the key emphasis of programs. There is a danger of funding trendy and weak research in the name of transformative science, but program officers are doing a good job of balancing these factors.

The disciplinary programs are primarily a collection of individual investigator awards, although many collaborations are evident. In some areas, a few very large awards were cut in size to make room in the budget for additional awards. Though undesirable, this was deemed appropriate under the budget constraints.

The CHE portfolio includes a large fraction of CAREER awards, and COV commends the actions of POs to include a vibrant group of young investigators. The success rates of PIs from underrepresented groups appear to be very similar to the average, and the slow but steady growth of these groups is encouraging. The support of workshops on equity issues related to gender, minorities, and persons with disabilities is highly commendable.

Support of individual investigators and instrumentation at PUIs appears to be appropriate. REU programs are also viewed positively by the community and are an important resource for research at PUIs. There was some discussion about the growth in international REU programs that are more expensive to run than domestic ones. Although the international REUs add an important dimension to the portfolio, the COV felt that these should not be funded at the expense of highly meritorious domestic programs.

ARRA funds were used to increase the number of CAREER and instrumentation grants in addition to reversing decisions on some borderline IIAs. The vast majority of these awards are seen as an extremely beneficial addition to the CHE portfolio. In addition, CHE should be commended for their successful competition for additional funding ($15M) to support the ICR MS facility at the National High Magnetic Field Laboratory.

The international component of the CHE portfolio has also increased substantially in the past 3 years, and the Division Director's efforts in this area are highly commendable.

A.4 Program Management

The CHE programs are actively and thoughtfully managed with good continuity and a high level of expertise. CHE Program Officers are very experienced and conduct themselves ethically and professionally in their decision-making processes. However, CHE is understaffed overall, and the balance between the expenses of additional panel reviews vs. hiring of part-time program officers should be re-evaluated. The long-term dedication of the executive officers is also noted with appreciation.

B. Outcomes of the Division's Investment in Research, Education and Infrastructure

The Chemistry Division of NSF supports basic science in the chemical sciences in the U. S. The diverse portfolio of CHE-funded projects has led to high impact basic science with ramifications in applied areas that are crucial to national priorities. The outcomes listed below give a sampling of the results obtained from this investment in 3 areas, Discovery, Learning and Research Infrastructure. Among the many national and international prizes given to CHE grantees, we are pleased to recognize the 2009 Nobel Laureate, Prof. Jack Szostak of Harvard University (CHE 0809413, highlighted below) and the 2006 Nobel Laureate Roger Kornberg of Stanford University whose project entitled "Synthesis and Structure of Gold Nanoparticles," (CHE 0617050) was awarded just prior to the announcement of the prize.

B.1 Discovery Outcomes

CHE supports fundamental science and discovery in the broad discipline of chemistry for the US. This is not a top-down driven process and projects are not selected based on application area or area of impact. However, out of the diverse portfolio of CHE-funded projects has sprung high impact science in application areas that are identified as critical to national priorities. These are fundamental groundbreaking studies that end up furthering knowledge and pushing discovery in relevant and broadly multidisciplinary application areas. In selecting high impact science from among the abundance of exciting projects within the CHE portfolio, we found that many naturally grouped into these critical and timely topics: Energy, Environment, National Security and Industrial Competitiveness, Chemistry of Life Processes, and Cool Chemistry.

Energy: The energy crisis will have chemistry at the center of its multifaceted solution. Indeed, this was highlighted in the U.S. National Science Foundation Division of Chemistry Strategic Directions 2008-2012 document. Following are examples of NSF Chemistry Division supported projects that have made transformative contributions to this area.

Award: 0802907
Title: Powering the Planet: A Chemical Bonding Center in the Direct Conversion of Sunlight into Chemical Fuel, PI: Harry Gary.
A new O_2-generating catalyst that captures many of the functional elements of photosynthesis self-assembles from water and the oxidation of Co^{2+} to Co^{3+} in the presence of phosphate. The discovery provides a way to store solar energy and is on a path for the large scale deployment of solar energy.

Award: 0750234
Title: Fe-mediated C-O cleavage and C-C Bond Forming Reactions from CO_2 and CO Substrates, PI: Jonas Peters.
New (phosphinoborate)iron(I) compounds that are structurally unusual by virtue of their relatively low coordination numbers and geometry feature iron-nitrogen multiple bonds. These complexes have been found to mediate C-O cleavage pathways that effect partial or complete CO extrusion or reductive C-C coupling to produce oxalate. The ability to activate carbon dioxide and release iron carbonyl products opens the door to using carbon dioxide as a synthon for C-C coupling reactions that exploit CO as a carbene or carbyne precursor. That is, atmospheric carbon dioxide can be used as a synthetic chemistry precursor.

Award: 0543133
Title: Biodegradable Copolymers Produced from Carbon Dioxide and Epoxides by Well-defined Metal Catalysts:Mechanistic and Technology Enabling Studies, PI: Donald Darensbourg.
Current routes to commercial polycarbonate materials employ phosgene, a hazardous CO source, so a greener and more benign technology for synthesizing these polymers would have important industrial implications. Conversion of carbon dioxide, a greenhouse gas, to useful copolymer products is the goal of this project and this has been shown to be a feasible alternative. Carbon dioxide can be used as a reagent that can couple with epoxides to form biodegradable copolymers.

Award: 0936940
Title: Photoelectrocarboxylation as an Energy-Efficient Method for CO_2 Utilization, PI: Landy Blasdel.
Landy Blasdel of Pennsylvania State University is an American Competitiveness in Chemistry Fellow. She has investigated the mechanism of photoelectrocarboxylation of alkyl halides on semiconductor surfaces. She works in collaboration with scientists at Penn State University and with collaborators at Brookhaven National Laboratory. In her plan for broadening participation, Dr. Blasdel works in a one-on-one setting with young people (elementary- through high-school age), including students in the State College School District, targeting girls and underrepresented minorities, including students in the Philadelphia area.

Environment: An important strategic goal of the Division of Chemistry involves supporting innovative basic chemical research that has applications in addressing environmental problems. The following projects provide examples of how fundamental investigations can lead to important breakthroughs in this area.

Award: 0910513
Title: Lamellar Inorganic Salts as Building Blocks for Functional Molecules, PI: Thomas Mallouk.

Thomas Mallouk of Penn State University has developed an environmentally-friendly and inexpensive means of creating nanometer-sized iron particles based on the ancient chemistry of iron smelting. These "nanoparticles" of elemental iron are promising agents for detoxifying soil and groundwater contaminated with chlorinated organic solvents as well as notorious toxic heavy metal ions such as hexavalent chromium.

Award: 0749571
Title: Expanded Porphyrins and Other Synthetic Polypyrrole Macrocycles, PI: Jonathan Sessler.
Jonathan Sessler of the University of Texas at Austin, working with Dr. Bruce Moyer of Oak Ridge National Laboratory, has developed a molecule that can specifically recognize the chemical species sulfate. This discovery is expected to dramatically increase the efficiency of certain processes used to store nuclear waste.

Award: 0709994
Title: A Green Fieldable Analyzer for Arsenic Detection, PI: Purmendu Dasgupta.
Purmendu Dasgupta of the University of Texas Arlington has developed an inexpensive, remarkably simple device for the detection of arsenic in drinking water. Arsenic is a toxic contaminant of drinking water and is a particularly serious problem in developing countries.

Award: 0715014
Title: Solvated Salts and Acids: Contributions to Basic Understanding of Nucleation, Particle Growth, and Aerosol Chemistry, PI: A. W. Castleman.
A. W. Castleman of Penn State University has determined how weak acids like formic acid lead to aerosol and particle formation, a discovery with significant implications for understanding climate change.

Award: 0303958
Title: Complexation Studies of Heavy Metal Ions by Crown Polythioethers and Related Macrocyclic Ligands, PI: Gregory Grant.
Gregory Grant of University of Tennessee-Chattanooga has discovered a new compound containing cadmium bound to an organic molecule that reacts with carbon dioxide and has potential utility for chemically binding gaseous carbon dioxide in smokestack "scrubbers".

National Security (Trace Detection) and Industrial Competitiveness (Catalysis): Chemistry has been enabling in the discovery of new sensors for detection of chemical and biological targets relevant to national security, such as anthrax, bacteria, and nerve agents, as well as new methodologies to decrease the occurrence of false positive detection of these targets. Advances in chemistry have also empowered industrial competitiveness through innovative methods, generally known as catalysts, which increase efficiency and often reduce the waste stream in manufacturing of synthetic fuels, polymers, and other products traditionally derived from the petrochemical industry.

Award: 0611944
Title: Metal Coordination Compounds as Reporters for Biological NO, PI: Stephen Lippard.
MIT and New York University researchers have identified a weakness in the defenses of the anthrax bacterium that could be exploited to produce new antibiotics. The researchers found that nitric oxide (NO) is a critical part of acillus anthracis's defense against the immune response launched by cells infected with the bacterium. Anthrax bacteria that cannot produce nitric oxide succumb to the immune system's attack. Stephen Lippard, the Arthur Amos Noyes Professor of Chemistry at MIT and an author of a paper on the work, said antibiotics developed to capitalize on this vulnerability could be effective against other bacteria that employ the same defense system. Those bacteria include Staphylococcus aureus, which commonly causes infections in hospitals and can be extremely drug-resistant.

Award: 0416553
Title: Whole Cell and Regulatory Protein-Based Sensors in Bioanalysis, PI: Sylvia Daunert.
Dr. Sylvia Daunert and collaborators at the University of Kentucky developed a sensitive, selective, and reproducible method for the rapid detection of bacterial signaling molecules in human saliva and stool samples. These signaling molecules mediate the cell-to-cell communication between bacteria and their concentration reflects the bacterial population density. This cost-effective whole-cell based biosensing system could be employed in the diagnosis and management of various bacteria-related disorders, such as Crohn's disease.

Award: 0547895
Title: CAREER: Conjugated Systems Displaying Tunable Energy Transfer: Fundamental Principles and Applications, PI: Evgueni Nesterov.
The development of robust and sensitive materials for real-time detection of chemical targets is important in a broad range of practical areas. Fluorescent polymers with alternating single and multiple chemical bonds (conjugated molecules) are an attractive basis for the design of low detection limit sensing devices, however, they often lack selectivity towards the chemical target resulting in frequent occurrence of "false-positive" alarms.

Award: 0645094
Title: CAREER: Research and Education in Ambient Mass Spectrometry with Applications in Counterfeit Drug Detection, PI: Facundo Fernandez.
Researchers at the Georgia Institute of Technology developed a rapid chemical test (assay) based on mass spectrometry to screen the quality of artesunate-based antimalarial drugs in Southeast Asia and several African countries. The researchers used the assay to test the quality of hundreds of tablets in a short period of time. Their work allowed an international team to make evidence-based hypotheses as to where some of the fake artesunate was manufactured. Armed with this information, authorities in China and the International Criminal Police Organization, or INTERPOL, acted quickly to stop counterfeit production and dissemination of the fake drugs.

Award: 0616660
Title: Chirped-Pulse Fourier Transform Microwave (CP-FTMW) Spectroscopy: True Broadband Microwave Spectroscopy for Chemical Kinetics Measurements Using Dynamic Rotational Spectroscopy, PI: Brooks Pate.
Soman was the last wartime-discovered nerve agent. Characterized as a corrosive, volatile, colorless liquid with a faint odor, Soman also known as GD by NATO, is one of the world's most dangerous military weapons. It is more lethal and persistent than Sarin. Dr. Brooks Pate and co-workers characterized the analog of Soman, known as inacolone, by the newly developed chirped-pulse Fourier transform microwave spectrometer. The measurements provide a "fingerprint" of the molecule that allow for unambiguous species identification in complex mixtures. Because the detection is by a beam of radiation, the method can provide "standoff" early warning monitoring. This work was presented at the 2006 International Symposium on Spectral Sensing Research: Rapidly Advancing Spectroscopic (DC to X-ray) Sensing Science and Technology Base.

Award: 0647152
Title: Guided Motion at Surfaces: Exploratory Research towards Molecular-Scale Machinery, PI: Ludwig Bartels.
Professor Ludwig Bartels, Associate Professor of Chemistry at the University of California Riverside and his collaborator, Michael Marsella, are working to create molecular-scale, 'ratchet-like' machinery, that is, molecules capable of changing the position or properties of separate, molecular-scale objects in a predetermined fashion. Ultimately, Bartels plans to further the field of molecular machinery by anchoring

molecular machines onto a surface and allowing molecules to move in a linear motion across the surface. In other words, Bartels is working on creating systems where molecules 'walk' on a surface in one direction and even, in some cases, carry 'cargo', thus serving as a molecular transporter.

Award: 0434568
Title: Center for the Activation and Transformation of Strong Bonds (CATSB), PI: Karen Goldberg.
Alan Goldman of Rutgers University and Maurice Brookhart of the University of North Carolina have developed a remarkably versatile technique for converting wastes, coal, or almost any source of carbon into synthetic diesel and gas. This technique builds upon the Fischer-Tropsch process which was invented for making synthetic fuel in Germany more than 80 years ago. Called alkane metathesis, this new technique uses the undesirable low molecular weight hydrocarbons (chain lengths of 4 to 8 carbon atoms) produced from the Fischer-Tropsch process and recombines them into chains of useful lengths (chain lengths of 1to 3 and 9 to 18 carbon atoms). For example, it can transform two 6-carbon chains into a 2-carbon chain (a good heating gas) and a 10-carbon chain (perfect as a diesel fuel). Improving the method's yield and efficiency could allow the US to convert some of its abundant coal supplies into synthetic fuels, reducing the nation's dependence on imported oil. This work is funded as part of a CCI grant entitled "Center for Activation and Transformation of Strong Bonds."

Award: 0719575
Title: Experimental and Theoretical Studies of Bifunctional Organometallic Catalysis, PI: Douglas Grotjahn & Andrew Cooksy.
With bifunctional catalysis, they were able to develop catalysts for anti-Markovnikov hydration of alkynes which are more than 1000 times faster than others reported in the literature, accomplishing within minutes a reaction that would take more than a million years to complete without catalyst! This work has also led to a patented catalyst which is sold by Strem Chemicals.

Award: 0747778
Title: CAREER: Small Molecule Synthesis via Iterative Cross-Coupling, PI: Martin D. Burke.
His work marks a new level of applicability of one of the most important reactions for carbon-carbon bond formation (the Suzuki-Miyaura reaction). His group has published several important papers and his chemistry is well accepted by the community. His work was highlighted with a full story by Stu Borman in Chemical and Engineering News (2007, v 85(25), pp 63-64). He was also invited to submit an Organic Syntheses procedure for their new chemistry. More than 50 of their reagents are already made commercially-available worldwide by Sigma-Aldrich.

See also examples of Water as a Catalyst in the Atmosphere and for Heterogeneous Reactions in the Atmosphere from workshop report "Workshop on Some Current Issues in Environmental Chemical Sciences", June 8-9, 2009,
http://www.chem.uci.edu/airuci/NSFwkshpRptJune2009.pdf

Chemistry of Life Processes: There is obvious synergy between chemical and biological disciplines particularly when it comes to molecular synthesis, molecular identification of species, and the study of complex multistep reactions. Many of the principles and techniques that have been developed for chemical analysis and are central to the chemical discipline have been leveraged into the biological landscape to enable discovery. This has been recognized in recent years by extensive cross talk and collaboration between the Division of Chemistry and the Division of Molecular and Cellular Biosciences, and is evidenced in some of the program highlights funded by CHE. These are grouped into two areas: advances made in chemistry/materials for biological imaging, and advances in elucidating biochemical processes.

Chemistry/Materials for Biological Imaging:

Award: 0413857
Title: Fullerene Based Supermolecular Assemblies, PI: Alan Balch.
Researchers Alan Balch and Marilyn Olmstead of the University of California-Davis (UCD) in conjunction with Harry Dorn of Virginia PolyTechnic Institute and State University (VT) have uncovered a distinctly egg-shaped fullerene whose asymmetric structure deviates from all previous expectations in this area of research. Fullerenes like this with metal ions on the inside are of interest in the biomedical field as relaxation agents for magnetic resonance imaging (MRI).

Award: 0923604
Title: EAGER: Meso-Polymers, PI: Joseph DeSimone.
New technology developed at the University of North Carolina, referred to as "PRINT" (Particle Replication In Non-wetting Templates), has enabled manufacture of nano- and micro-particles in a wide variety of sizes and shapes; such particles can be targeted to specific sites in the body, serving as carriers of conventional anti-tumor drugs and other medicines, or contrast agents that enhance X-ray and MRI scans for better diagnosis.

Advances in Elucidating Biological Processes:

Award: 0349034
Title: CAREER: Functional Chemical Models of Complex Biochemical Networks, PI: Rustem Ismagilov.
Blood clotting, like many biological functions, is governed by networks of biochemical reactions in the veins and arteries. Ismagilov has devised a simple chemical model that was used to reproduce the critical characteristics of hemostasis (localized clotting) in artificial channels (microfluidics) having geometries resembling human blood vessels. This work suggests that the proper function of hemostasis is dependent on the geometry of the junctions between vessels, and enables the basic understanding of the blood clotting biochemistry important for hemophilia and wound treatment.

Award: 0545138
Title: CAREER: Determining the Role of Metal Coordination in Selenium Antioxidant Activity. An Interdisciplinary Approach to Chemical Biology Education and Research, PI: Julia Brumaghim.
The Brumaghim research group has discovered that polyphenol antioxidants, including four in green tea, prevent up to 100% DNA damage from iron-generated hydroxyl radicals at biological concentrations. In addition, they have determined that binding of the antioxidant to iron is responsible for the observed DNA damage prevention. This observation has allowed them to develop the first predictive model of polyphenol antioxidant potency based on chemical properties of the compounds.

Award: 0809413
Title: Self-Replicating Nucleic Acids, PI: Jack Szostak.
A team of researchers at Harvard University have modeled in the laboratory a primitive cell, or protocell, that is capable of building, copying and containing DNA. Since there are no physical records of what the first primitive cells on Earth looked like, or how they grew and divided, the research team's protocell project offers a useful way to learn about how Earth's earliest cells may have interacted with their environment approximately 3.5 billion years ago.

Award: 0547566
Title: CAREER: Stereocontrolled Synthesis of 1,2-cis Glycosides, PI: Alexei Demchenko.
Elucidation of the exact mechanisms of carbohydrate involvement in the cause, development, and effects of many human diseases is difficult due to their complexity and relatively low availability. Professor Demchenko and his co-workers obtained compounds that mimic natural pneumococcal oligosaccharides of Serogroup 6, which has been ranked within the top three causes of invasive pneumococcal disease.

Such a disease is a leading cause of serious illness in children and adults throughout the world. The disease is caused by a common bacterium, the pneumococcus, which can attack different parts of the body. Over 2 million children will die this year worldwide; the synthesis of pneumococcal saccharides will accelerate development of synthetic vaccine components for this disease.

Award: 0640934
Title: Fluorous Proteins: Structure, Stability, and Biological Activity, PI: E. Neil Marsh
A possible solution to the problem of drug-resistant bugs has emerged from research performed at the University of Michigan. By creating "Teflon-like" versions of natural antibiotics found in frog skin, Marsh has made the potential drugs better at thwarting bacterial defenses. Importantly, such compounds have actually been found to be significantly better at killing some bacteria than the original molecules extracted from frogs, thereby offering promising prospects for development of new therapeutic strategies.

Cool Chemistry: Often it is difficult to imagine just how impactful fundamental advances in chemistry will be. These discoveries lead to new materials and processes that are used broadly in every area imaginable and support the nation's broad industry sectors. Advances in fundamental chemistry continue to surprise and enlighten scientists, and set the basis for new discoveries.

Award: 0352599
Title: Orchestrating Photochemistry, Energy Transfer and Electron Transfer in Multichromophoric Molecular Systems, PI: J. Devens Gust.
A team of NSF funded researchers were able to model a photochemical compass that may simulate how migrating birds use light and Earth's weak magnetic field to navigate. The photochemical model becomes sensitive to the magnitude and direction of weak magnetic fields similar to Earth's when exposed to light. The research funded by the National Science Foundation (NSF) demonstrated that this phenomenon, known as chemical magnetoreception, is feasible and gave insight into the structural and dynamic design features of a photochemical compass. Amongst other things, this work showed that the magnetic compass sense of migratory birds is based on a magnetically sensitive chemical reaction whose lifetime depends on the orientation of its molecules to Earth's magnetic field.

Award: 0613306
Title: Chemical Bonding Across the Periodic Table, at High and Ambient Pressures, PI: Roald Hoffmann.
Even though the lightest known metals in the universe, lithium (Li) and beryllium (Be), do not bind to one another under normal atmospheric or ambient pressure, an interdisciplinary team of Cornell scientists predicted in the Jan. 24 issue *Nature* that Li and Be will bond under higher levels of pressure and form stable Li-Be alloys that may be capable of superconductivity. Superconductivity is the flow of electricity with zero resistance.

Award: 0719157
Award Title: Early Metal Mediated Chemistry of the Group 15 Elements, PI: Christopher Cummins.
While nature is able to utilize atmospheric nitrogen in biological systems, modern chemical science is still seeking technologies for economical usage of elemental nitrogen. This project grows from the recent discovery of molybdenum and niobium compounds that can cleave the nitrogen-nitrogen bond in dinitrogen under mild conditions. In order to utilize this chemistry, the nitrogen atoms derived from metal assisted dinitrogen cleavage will be used to prepare organic nitrogen compounds. In addition, related processes will be devised to use phosphorus and arsenic atoms derived from elemental phosphorus and arsenic, respectively.

Award: 0317154
Title: RNA Tectonics and Self-assembling RNA Nano-devices, PI: Luc Jaeger.

This project relates to RNA tectonics, a concept that refers to the fabrication of RNA self-assembling architectures and nano-devices with novel properties by taking advantage of the knowledge of motifs, folding and assembly rules governing the three-dimensional shape of complex natural RNA molecules. Like organic chemistry that allows an infinite number of molecules to be build with the same subset of synthons, RNA tectonics open the way to the design of an infinite number of RNA supra and macromolecules by judiciously using known RNA motifs and modules. General principles of RNA tectonics will be explored and applied to the design of smart, programmable 2D RNA arrays for generating templates with desirable topography for bottom-up fabrication of nano-electronic devices.

B.2 Learning Outcomes

The COV pays tribute to the fact that CHE continues to be a leader in the establishing innovative programs at NSF. For example, the CAREER program and the REU program both have early ties to CHE before being instituted NSF-wide. Developing a world-class scientific workforce from diverse backgrounds while promoting scientific literacy for all citizens are challenging goals. CHE has effectively invested in projects that provide programs for the best and brightest students and provide access to chemistry education and research outcomes for all. Some of the outstanding projects in this area are outlined below.

Build strong foundations and foster innovation to improve K-12 teaching, learning, and evaluation in science and mathematics.
In NSF Career Award #0645818, entitled "Mechanistic Analysis of Nitrogen Oxide Chemistry under Biologically Relevant Conditions", PI Katrina Miranda is "directing an REU program at the University of Arizona, implementing a sabbatical program for chemistry faculty employed in the Arizona Community College system and mentoring prospective students from Arizona high schools and freshmen enrolled in the UA College of Science".

Develop methods to effectively bridge critical junctures in STEM education pathways.
In a project entitled "How Do Carbon Emissions Cause Global Warming? An Interactive University – High School Project", students from Highland Park High School in New Jersey, along with their teacher, worked with students from Rutgers University. Together they "designed and implemented a scalable pilot program that conveys, empirically, the key concepts underlying global warming."

Prepare a diverse, globally engaged STEM workforce.
The REU sites supported by CHE provide an effective mechanism for training the next generation of chemical scientists and for broadening the participation of underrepresented groups. For each of the years during the three year period covered by the COV review, domestic REU sites served an average of approximately 500 students at 50 sites. Additionally, an international component of the program, iREU, served an average of approximately 60 students at six sites. An exemplary REU project is entitled "REU Site: Research Experiences for Undergraduates in Chemistry and Biochemistry (award # 0552722). With this award PI David Collard of Georgia Tech supported "ten students from diverse backgrounds in an array of projects in analytical, biological, inorganic, organic, and physical, and polymer chemistry."

Additionally, the three NSF workshops to promote equity with respect to gender, race and ethnicity, and disability status have had a transformative impact on the climate in the academic chemistry community. The Workshop on Building Strong Academic Chemistry Departments through Gender Equity (#13102, PI Celestine Rolfing, UCLA); the Workshop on Excellence Empowered by a Diverse Academic Workforce: Achieving Racial and Ethnic Equity in Chemistry" (Award # 0735302); and the "Workshop on Excellence Empowered by a Diverse Academic Workforce: Chemists, Chemical Engineers, and Materials Scientists with Disabilities (Award #0854967**)** helped participants learn how to reduce or eliminate bias in academia.

Engage and inform the public in science and engineering through informal education.
Janet Iwasa of Harvard University was awarded a Discovery Corps Postdoctoral Fellowship for her project entitled “Visualizing the Chemical Origins of Life for Research and Education”. The project allowed her to bring “cutting-edge academic research to exhibits at the Boston Museum of Science.”

The Division of Chemistry has funded numerous projects that address the sustainability of the chemical workforce by focusing on developing scientific talent in students, K – 16. For example, David Tyler of the University of Oregon, Eugene (Award #0809393) runs a one-week summer enrichment program called "PolyCamp" that teaches undergraduates from across the country about polymer science and about the sustainability aspects of plastics. And Liam Pingree of the University of Washington (Award #0725139) works with art students in Marketing based alternative energy education in Seattle. And Professor John Tully of Yale University (Award # 0615882) teaches “The Best Science Class Ever!” to students in a non-majors chemistry class that focuses on current social issues and provides a demonstration pertaining to the topic of the day *every* class session.

In addition to the projects described above, the Division of Chemistry funds projects in a variety of other areas, such as Research Experiences for Teachers (RET) and International Collaborations. In a project entitled “Introducing Young Researchers to International Collaborations” (Award # 0611887), Timothy Swager funded young scientists to attend a workshop near Oxford, England, in which they formed relationships with colleagues from the United Kingdom.

The CHE funded projects described above leverage NSF dollars to make substantial and broad impacts in the chemistry community. Based on the outstanding projects resulting from awards made in 2007 – 2009, the COV expects that the Division of Chemistry will continue to fund projects that will improve the opportunities for development of world class scientists and scientifically literate citizens.

B.3 Research Infrastructure Outcomes

Modern chemical instrumentation provides sensitive and selective tools for molecular characterization critical to scientific discovery. The development of new tools enables breakthrough discoveries in all areas of chemical sciences. NSF-funded developments in novel chemical imaging (0555314, 0618477), and mass spectrometry instrumentation for field studies of atmospheric aerosols (0923159), ion detection, including the recently commercialized Orbitrap (0216239), and analysis in an open laboratory environment (0848650), enable important new types of chemical measurements. Tools based on molecular spectroscopy using microwave rotational transitions (0215957) and non-linear optical probes of interfaces (0722558) have led to advances in trace detection. Optical spectroscopy methods are broadly applicable, with applications ranging from medical diagnostics (0209898) to explosives detection (0515670).

Advanced computation and cyberinfrastructure build electronic resources to enhance chemistry discovery (0535656, 0317072), establish virtual communities (0326027) and provide broad-based access to resources through remote accesses instrumentation (0840507). New software (0535616) and simulation tools (0535640) create the ability to visualize chemical reactions through movies on a molecular level.

National user facilities such as ChemMatCARS (0822838), the National High Magnetic Field Laboratory (NHMFL) and National Nanotechnology Infrastructure Network (NNIN) provide centralized resources containing state-of-the-art instruments that both serve as a measurement resource for the scientific community and as centers for advanced instrument development.

The Chemistry Division wisely invested a significant proportion of ARRA funds on instrumentation facilities and development which will have a long-term and broad-based impact on scientific discoveries. Ready access to high-field NMR and mass spectrometers and x-ray diffractometers is vital for accelerating new molecular discoveries. Programs such CRIF and MRI fund instrumentation that advance current research, and provides instruction and training for the next generation of scientists at a diverse set of institutions. In addition, CHE successfully competed within NSF for an additional $15M of ARRA funding for an ICR MS facility addition to the NHMFL.

IV. Response of the Chemistry Division to the 2007 COV Report

CHE responded with sincerity, clarity and action on the 2007 COV report. The COV was particularly interested in issues related to transparency, improving the effectiveness of the review process and in assessment of the two submission windows, new programs, and broader impacts. We summarize these responses according to the points enumerated below.

1. CHE was urged to develop a strategic plan, and they did so. The Strategic Directions document http://www.nsf.gov/attachments/116169/public/che_strategic_directions_2008_2012.pdf provides guidance for CHE staff in outlining goals for the Division for the coming years. This is particularly important at a time when the agency is predicted to experience unprecedented growth in its budget. The outcomes of this plan have included the ACC Fellows program which supports postdoctoral fellows who collaborate between university and industrial settings, the support of pilot activities in communicating the value of chemistry to the public, an increase in global engagement by partnering with OISE and foreign funding agencies, the acquisition of additional support for Centers for Chemical Innovation, the support of activities (workshops, COACh, etc.) that broaden participation in chemistry, and a major update or "realignment" of the Division of Chemistry structure. All of the above activities have been conducted with outstanding success, so far as we can tell at this stage. The realignment, moving away from classical subdisciplines to 8 new research clusters, was seen as an effort by the Chemistry Division to be responsive to the scientific directions set by the broader community rather than a top-down setting of direction. The COV was impressed by the bold directions set through this reorganization, but also recognized the need for formal assessment of the effectiveness of the new structure over the next three-year period.

Two goals of the Strategic Directions have not yet been realized: "Addressing Funding Needs of Investigators across Career Stages," and "Assessing the Impact of the Broader Impacts Review Criterion." These goals appear in our 2010 COV recommendations (part A).

2 and 3. CHE was asked to address the "shrinking dollars" in CHE grants and to protect the core of the portfolio in individual investigator grants. Because of the America Competes Act and cogent arguments on the part of the Division Director Luis Echegoyen, some additional funding became available to CHE over the past few years. The budget for IIAs has increased modestly, but the most successful request has been to develop and expand the Centers for Chemical Innovation. These Centers are viewed as a key investment in Grand Challenge research that benefits both the community of chemists and society at large. Increasing the number and nature of large, collaborative centers is important but should be weighed carefully so that the core of the discipline does not suffer.

4. The 2007 COV asked that POs improve their communication with PIs, especially the ones whose applications are declined. CHE responded by creating "PO Comments" which contain much of the information of the Review Analysis (edited to remove identities and sensitive information). This is viewed by the 2010 COV as an excellent improvement and we urge continuation and refinement of the process.

The 2007 COV commented on the use of panels, which we find, in 2010, to be a continually evolving process. We urge CHE to continue to evaluate the use of panels in combination with ad hoc reviews and to investigate other methods that might improve the effectiveness and efficiency of the review process.

5. Responding to a request, CHE initiated a study of the role of broader impacts in its funded activities by contracting with a company to evaluate a number of randomly selected awards. For a variety of reasons, the study was incomplete, and we recommend that it be pursued, either by CHE, by MPS or NSF-wide.

6. CHE responded appropriately to the 2007 COV by increasing the portfolio of REU awards, particularly internationally, and by organizing jointly with NIH an instrument development workshop at the chemistry-biology interface.

7. The 2007 COV recommended increasing the number of on-site permanent Program Officers. CHE now has 9 permanent POs and about a 1:1 ratio of permanent:rotating POs. This is a good outcome as it should ensure that each subdiscipline has institutional memory and can move forward with efficacy. However, proposal pressure creates a workload for POs that is barely sustainable, and new resources are needed for additional staff.

8. CHE is commended for being able to meet the challenge of acting on 80% of proposals within 6 months in 2007 and 2008. ARRA funding in 2009 created an understandably large burden for POs and the processing time suffered accordingly.

V. Concluding Remarks

In summary, the COV finds that the Division of Chemistry is playing a critical role in funding the best research and education in chemical sciences. Furthermore, CHE is a leader in organizational excellence as manifested in international and domestic workshops at the forefront of emerging disciplines, Grand Challenges, and issue of broadening participation. The outcome of CHE's investments is an outstanding portfolio of science, people and tools.

Nevertheless, the funding for basic research in chemistry and the funding for scientific staff (POs) in CHE is truly marginal. If the U. S. expects to remain in a global leadership position and to foster its technology-driven economic base, budgets must grow.

The COV would also like to take this opportunity to thank CHE Division Director Luis Echegoyen for his four years of tireless service to NSF and the community. His leadership, dedication and wisdom in guiding the ship of Chemistry have moved the institution and the community immeasurably forward. We wish him success in his future endeavors.

APPENDIX A
Membership of the COV
2010 Division of Chemistry (CHE) Committee of Visitors (COV)

Dr. Cynthia J. Burrows (Chair)
University of Utah
Department of Chemistry
315 S. 1400 East
Salt Lake City, UT 84112
Phone: 801-585-7290
Fax: 801-581-6681
burrows@chem.utah.edu

Dr. Paul Barbara
University of Texas
Dept. of Chemistry & Biochemistry
University of Texas
Austin, TX 78712
Phone: 512-471-2880
Fax: 512-471-3389
p.barbara@mail.utexas.edu

Dr. Markus Behnke
Deutsche Forschungsgemeinschaft (DFG)
Chemistry and Process Engineering
Kennedyallee 40
53175 Bonn
Germany
Phone: 49 (228) 885-2181
Fax: 49 (228) 885-2777
markus.behnke@dfg.de

Dr. Kristin Bowman-James
University of Kansas Main Campus
1251 Wescoe Hall Drive
Malott Hall, Room 1017
Lawrence, KS 66045
Phone: 785-864-3669
Fax: 785-864-5396
kbjames@ku.edu

Dr. Ron Brisbois
Macalester College
Dept. of Chemistry
1600 Grand Avenue
St. Paul, MN 55105
Phone: 651-696-6270
Fax: 651-696-6432
brisbois@macalester.edu

Dr. Arthur Cammers
University of Kentucky
Department of Chemistry
349 Chemistry-Physics Building
Lexington, KY 40506-0055
Phone: 859-323-8977
Fax: 859-323-1069
a.cammers@uky.edu

Dr. Sally Chapman
Barnard College
Department of Chemistry
3009 Broadway
New York, NY 10027
Phone: 212-854-2098
schapman@barnard.edu

Dr. Larry R. Dalton
University of Washington
Department of Chemistry
PO Box 351700
Seattle, WA 98195-1700
Phone: 206-616-5745/206-543-1686
Fax: 202-616-8602
dalton@chem.washington.edu

Dr. Rick L. Danheiser
Massachusetts Institute of Technology
Department of Chemistry, Rm 18-297
77 Massachusetts Avenue
Cambridge, MA 02139-4307
Phone: 617-253-1842
Fax: 617-258-7500
danheisr@mit.edu

Dr. Juan de Pablo
University of Wisconsin-Madison
3018 Engineering Hall
1415 Engineering Drive
Madison, WI 53706-1691
Phone: 608-262-7727
Fax: 608-262-54354
depablo@engr.wisc.edu

Dr. Peter K. Dorhout
Colorado State University
Department of Chemistry
Campus Delivery 1005
Fort Collins, CO 80523
Phone: 970-491-6817
Fax: 970-491-2194
pkd@lamar.colostate.edu

Dr. Michael P. Doyle
University of Maryland
Dept of Chemistry & Biochemistry
0107 Chemistry Building
College Park, Maryland 20742
Phone: (301) 405-1788
Fax: (301) 314-9121
mdoyle3@umd.edu

Dr. Miles Fabian
National Institute of General Medical Sciences
45 Center Drive MSC 6200
Bethesda, MD 20892-6200
Phone: (301) 594-3827
Fax : (301) 496-7301
fabianm@mail.nih.gov

Dr. Joanna S. Fowler
Brookhaven National Lab
Department of Chemistry
PO Box 5000
Upton, NY 11973
Phone : 631-344-4365
Fax : 631-344-7902
fowler@bnl.gov

Dr. Gregory Hillhouse
University of Chicago
Department of Chemistry
929 East 57th Street
Chicago, IL 60637
Phone: 773-702-7057
Fax: 773-702-0805
g-hillhouse@uchicago.edu

Dr. Joseph M. Jasinski
IBM Corporation
Watson Research Center (Hawthorne)
17 Skyline Drive
Hawthorne, NY 10532...
Phone : 914-784-5324/914-784-7100
Fax : 914-784-7200/914-784-6324
jmjasin@us.ibm.com

Dr. Kerry K. Karukstis
Harvey Mudd College
Department of Chemistry
301 Platt Boulevard
Claremont, CA 91711-5990
Phone : 909-607-3225
Fax : 909-607-7577
kerry_karukstis@hmc.edu

Dr. Bruce D. Kay
Pacific Northwest National Laboratory
PO Box 999, K8-88
Richland, WA 99352
Phone: 509-371-6143
Fax: 509-371-6145
bruce.kay@pnl.gov

Dr. Wei Kong
Oregon State University
Department of Chemistry
Gilbert 153
Corvallis, OR 97331-5503
Phone : 541-737-6714
Fax : 541-737-2062
wei.kong@oregonstate.edu

Dr. Cynthia K. Larive
University of California-Riverside
Department of Chemistry
500 Big Springs Road, PS1, Room 3028
Riverside, CA 92521
Phone : 951-827-2990
Fax : 951-827-4713
cindy.larive@ucar.edu

Dr. Marsha Lester
University of Pennsylvania
Department of Chemistry
231 S. 34th Street
Philadelphia, PA 19104-6323...
Phone : 215-898-8317/215-898-4640
Fax : 215-573-2112
milester@sas.upenn.edu

Dr. Laurie E. Locascio
National Institute of Standards & Technology
100 Bureau Drive, Stop 8124
Gaithersburg, MD 20899-8124.
Phone : 301/975-3130/301-975-2629
Fax : 301-977-0587/301-330-3447
laurie.locascio@nist.gov

Dr. Saundra McGuire
Louisiana State University
Center for Academic Success and Chemistry
B-31 Coates Hall
Baton Rouge, LA 70803
Phone : 225-578-6749
Fax : 225-578-2696
smcguil@lsu.edu

Dr. John D. Protasiewicz
Case Western Reserve University
Department of Chemistry
10900 Euclid Avenue
Cleveland, Ohio 44106
Phone: 216-368-5060
Fax: 216-368-3006
protasiewicz@case.edu

Dr. Kenneth Raymond
University of California-Berkeley
Department of Chemistry
531 Latimer Hall
Berkeley, CA 94720
Phone: 510-642-7219
Fax: 510-486-5283
raymond@socrates.berkeley.edu

Dr. Elsa Reichmanis
Georgia Institute of Technology
Chemical and Biomolecular Engineering
311 Ferst Drive, N.W.
Atlanta, GA 30332-0100
Phone : 404-894-0316
Fax : 404-894-2866
elsa.reichmanis@chbe.gatech.edu

Dr. Scott Saavedra
University of Arizona
Department of Chemistry,
PO Box 210041
1306 East University Boulevard
Tucson, AZ 85721
Phone: 520-621-9761
Fax: 520-621-8407
saavedra@u.arizona.edu

Dr. Jennifer Swift
Georgetown University
Department of Chemistry
37th and O Streets NW
Washington, DC 20057-1227
Phone: 202-687-5567
Fax: 202-687-6209
jas2@georgetown.edu

Dr. John C. Tully
Yale University
School of Engineering & Applied Science
225 Prospect Street, SCL 242
New Haven, CT 06511
Phone: 203-432-3934
Fax:203-432-6144
john.tully@yale.edu

Dr. Claudia Turro
Ohio State University
Department of Chemistry
100 West 18th Avenue
Columbus, OH 43210-1016
Phone: 614-292-6708
Fax: 614-292-1685
turro.1@osu.edu

Dr. Akos Vertes
George Washington University
Department of Chemistry
725 21st Street N.W.
Corcoran Hall 107
Washington, DC 20052
Phone: (202) 994-2717
Fax: (202) 994-5873
vertes@gwu.edu

Dr. Mary J. Wirth
Purdue University
Department of Chemistry
560 Oval Drive
West Lafayette, Indiana 47907-2084
Phone: 765-494-5328
Fax: 765-494-0239
mwirth@purdue.edu

Dr. Keith A. Woerpel
University of California, Irvine
Department of Chemistry,
1102 Natural Sciences II
Irvine, CA 92697-2025
Phone: 949-624-4239
Fax: 949-824-9920
kwoerpel@uci.edu

APPENDIX B
CHARGE TO THE COV

NATIONAL SCIENCE FOUNDATION
4201 Wilson Boulevard, Arlington, Virginia 22230

Office of the Assistant Director
Mathematical and Physical Sciences

January 5, 2010

Dear Member of the Committee of Visitors:

Thank you for agreeing to serve on the FY 2010 Committee of Visitors (COV) for the Division of Chemistry (CHE). The COV Review will take place at the NSF in Arlington, Virginia on Tuesday through Thursday, February 9-11, 2010; we expect to begin early Tuesday morning and conclude by 5 pm on Thursday. The COV is an *ad hoc* subcommittee of the Mathematical and Physical Sciences Advisory Committee (MPSAC). Your appointment to the COV commences January 1, 2010 and ends with the presentation of the COV report to the MPSAC on April 1, 2010. Dr. Cynthia Burrows has graciously agreed to chair the COV.

By NSF policy, each program that awards grants and cooperative agreements must be reviewed at three-year intervals by a COV comprised of qualified external experts. NSF relies on their judgment to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements and are made available to the public. The COV is charged to address and prepare a report on:

- the integrity and efficacy of processes used to solicit, review, recommend, and document proposal actions;
- the quality and significance of the results of the Division's programmatic investments;
- the relationship between award decisions, program goals, and Foundation-wide programs and strategic goals;
- the Division's balance, priorities, and future directions;
- the Division's response to the prior COV report of 2007; and
- any other issues that the COV feels are relevant to the review.

A more complete description of the charge to the COV is provided as an attachment. The COV report is made available to the public to ensure openness to the research and education community served by the Foundation.

Decisions to award or decline proposals are ultimately based on the informed judgment of NSF staff, based on evaluations by qualified reviewers who reflect the breadth and diversity of the proposed activities and the community. Systematic examination by the COV of a wide range of funding decisions provides an independent mechanism for monitoring and evaluating the overall quality of the Division's decisions on proposals, program management and processes, and results.

The review will assess operations of individual programs in CHE as well as the Division as a whole for three fiscal years: FY 2007, FY 2008, and FY 2009. The CHE programs under review include:

- Analytical and Surface Chemistry
- Inorganic, Bioinorganic and Organometallic Chemistry
- Organic and Macromolecular Chemistry
- Theoretical and Computational Chemistry
- Experimental Physical Chemistry
- Chemistry Research Instrumentation and Facilities (CRIF)
- Chemistry Education, Workforce and Special Projects
- Chemistry Centers

The meeting will begin with introductory sessions that will provide background on the COV process and an overview of the Division's programs and activities by the Division Director, Luis Echegoyen, and Acting Deputy Division Director, Katharine Covert. These sessions will be followed by presentations of the research grants programs and the facilities. Following these presentations, the COV will have an opportunity to examine program documentation and results and to gather information for their report. The Committee will also be given time for general discussion and conversation with program staff. The last day of the meeting will be spent primarily drafting the report.

The Chair of the COV will finalize and submit the full report by March 2 to allow time for comment and distribution of the report to the full MPSAC prior to their meeting on April 1-2, 2010.

Katharine Covert (703-292-4950, kcovert@nsf.gov) will send you an agenda and instructions to a password-protected website that will contain background information to assist you in conducting this review about 4 weeks prior to the meeting. Please feel free to contact Katharine or Luis if you have questions about the review.

The CHE Division Secretary, Elinor Bruno (703-292-8963, ebruno@nsf.gov), will contact you shortly with information about making travel and hotel arrangements.

Thank you again for your willingness to participate in this important activity.

Sincerely,

H. Edward Seidel
Acting Assistant Director

Enclosures: List of Members of FY 2010 CHE COV
Excerpt from COV guidelines

cc: Dr. Iain Johnstone, Chair MPSAC

Attachment: From Subchapter 300 of the NSF COV Guidelines:

366. The COV Core Questions and Reporting Template will be applied to the program portfolio and will address the proposal review process used by the program, program management, and the results of NSF investments. Questions to be addressed include

a) the integrity and efficiency of processes used to solicit, review, recommend and document proposal actions, including such factors as:
   (1) selection of an adequate number of highly qualified reviewers who are free from bias and/or conflicts of interest;
   (2) appropriate use of NSF merit review criteria;
   (3) documentation related to program officer decisions regarding awards and declines;
   (4) characteristics of the award portfolio; and
   (5) overall management of the program.

b) the relationships between award decisions, program goals, and Foundation-wide programs and goals;

c) results of NSF investments for the relevant fiscal years, as they relate to the Foundation's current strategic goals and annual performance goals.

d) the significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when these investments were made. Examples might include new products or processes, or new fields of research whose creation can be traced to NSF-supported projects.

e) the response of the program(s) under review to recommendations of the previous COV review

Appendix C
Agenda and Subpanel Membership

Agenda
Division of Chemistry
Directorate for Mathematical and Physical Sciences
2010 Committee of Visitors

Sunday, May 2

7-9 PM *(optional)* Informal Gathering in the Lobbibar, Crystal City Hyatt

Monday, May 3

7:30 AM Continental Breakfast (Fairfax Room)
8:20 AM Welcome
Cynthia Burrows, Chair, CHE COV
Luis Echegoyen, Division Director, CHE
8:30 AM Charge to the Committee of Visitors
Ed Seidel, Acting Assistant Director, Mathematical and Physical Sciences
8:40 AM Overview of Division
Luis Echegoyen, Division Director, CHE
9:40 AM Conflict of Interest Briefing
Morris Aizenman, Senior Science Associate, Mathematical and Physical Sciences
9:50 AM General Procedures, Reviewing a Jacket
Katharine Covert, Acting Deputy Division Director, CHE
10:00 AM Break, morning snack
10:15 AM First Program Review (Section A) *continues through to adjournment*
Introduction to Program by Program Directors
10:45 AM First Program Review
11:45 AM Working lunch in program review
3:30 PM Break, afternoon snack
4:00 PM Preparation of First Round Program Review Report
5:00 PM Adjourn, Dinner on your own

Tuesday, May 4

7:30 AM Continental Breakfast (Fairfax Room), *signup for Section B breakout groups*
8:00 AM Second Program Review (Section A) *continues through to 1:15. See assignments on next page*
Introduction to Program by Program Directors
8:30 AM Second Program Review
10:00 AM Refreshment Break
11:45 AM Working lunch in program review
12:15 PM Preparation of Second Round Program Review Report
1:15 PM Merge First and Second Reads of Program Review, Section A. *Continues through 2:45, concludes Section A. see assignments, bottom of this page*
2:45 PM Refreshment Break

3:00 PM Assemble for Outcomes (Section B) Breakout Groups
Discovery A: Arlington Room (Lester)
Discovery B: Fairfax Room (Danheiser)
Discovery C: Prince William Room (Raymond)
Discovery D: Room 400 (Locascio)

4:00 PM Assemble for Outcomes (Section B) Breakout Groups
Learning A: Arlington Room (Brisbois)
Learning B: Fairfax Room (McGuire)
Research Infrastructure A: Prince William Room (Larive)
Research Infrastructure B: Room 400 (Kay)

5:00 PM Adjourn, dinner on your own
(*Section B Group Leaders meet to merge reports)*

Wednesday, May 5

7:30 AM Continental Breakfast (Fairfax Room)
8:00 AM Outcomes Reports and Discussion (Section B Group Leaders)
9:00 AM Plenary Discussion of Section C questions (Burrows)
11:15 AM Open Discussion of any other divisional issues not covered in previous discussions
11:45 AM Assign pairs to write ARRA and Section C answers
12:00 PM Working lunch, writing reports on Section C, additional discussions
1:30 PM Preparation for briefing the AD
2:00 PM COV briefs Ed Seidel, AD/MPS, on findings and recommendations
3:00 PM Adjourn

First Program Review (Monday)

ASC	**IBO**	**OMC**	**PChem**	**Education**	**Infrastructure**	**Centers**
400	**403**	**459**	**462**	**Arlington**	**Fairfax**	**Prince Wm**
Behnke	Bowman-James*	Brisbois	Barbara	Dorhout	Fowler*	Cammers
Dalton	Hillhouse	Danheiser	Chapman	Karukstis*	Lester	dePablo
Larive	Protasiewicz	Fabian	Kay	McGuire	Locascio	Jasinski
Saavedra	Raymond	Swift	Kong	Doyle	Vertes	Reichmanis*
Wirth*	Turro	Woerpel*	Tully*			

Second Program Review (Tuesday AM)

ASC	**IBO**	**OMC**	**PChem**	**Education**	**Infrastructure**	**Centers**
400	**403**	**459**	**462**	**Arlington**	**Fairfax**	**Prince Wm**
Barbara*	Dorhout*	Cammers	dePablo	Chapman*	Kong*	Behnke
Brisbois	Fabian	Doyle	Karukstis	Kay	McGuire	Bowman-James
Jasinski	Reichmanis	Fowler	Lester	Larive	Swift	Dalton*
Locascio	Woerpel	Hillhouse	Raymond	Protasiewicz	Tully	Danheiser
Vertes		Turro*	Saavedra*		Wirth	

Merge Report (Tuesday PM)

ASC	**IBO**	**OMC**	**PChem**	**Education**	**Infrastructure**	**Centers**
400	**403**	**459**	**462**	**Arlington**	**Fairfax**	**Prince Wm**
Wirth*	Bowman-James*	Woerpel*	Tully*	Karukstis*	Fowler*	Reichmanis*
Barbara*	Dorhout*	Turro*	Saavedra*	Chapman*	Kong*	Dalton*
Behnke	Hillhouse	Brisbois	Kay	McGuire	Locascio	Cammers
Jasinski	Protasiewicz	Fabian	dePablo	Doyle	Vertes	Danheiser
Larive	Raymond	Swift	Lester			

Appendix D

FY 2010 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

Date of COV: May 3 – May 5, 2010
Program/Cluster/Section: Analytical and Surface Chemistry
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: 23 **Awards: 13** **Declinations: 10** **Other: 0**
Total number of actions within Program/Cluster/Division during period under review: 811 **Awards: 227** **Declinations: 584** **Other: N/A**
Manner in which reviewed actions were selected: Program Directors selected 4 clear awards, 8 awards in the "decision interval," 4 declinations in the "decision interval " and 2 clear declinations. The Chemistry Division Information Technology Specialist selected 5 proposal records randomly (1 award and 4 declinations). Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. The COV panels did not request additional proposals for the review.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question. Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: There was a mixture of methods used (panel, ad hoc) and the trend toward ad hoc was limited to some extent by the cost of running panels. A mixture of ad hoc and panel are appropriate; resources should be made available to retain this mixture. If proposal pressure increases and more ad hoc reviews are done, this will require additional program managers.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: In most cases, both review categories were thoroughly addressed; however, in a few outliers, there were not sufficient numbers of reviews to enable the program officer to adequately address all areas. The Program Officers took the initiative to carefully weigh all criteria in making the final decision and these were especially well addressed in the review analyses. Broader impact criteria seemed to be playing a significant and appropriate role. a) …there is variability in weighting as well as in expectations	a. Yes, mostly b. Yes c. Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: In most cases, the reviewers provided very detailed comments in their assessments. In some cases, Program Officers made the decisions to weight the reviews based on substance, which was appropriate. Too often the reviews are terse and unsubstantive, e.g., “this proposal is well thought out”, but there is no further explanation or insight. We suggest making the boxes bigger on the on-line review form to nudge people into providing more detailed reviews. The comments sometimes do not match the ranking. How about if reviewers no longer gave rankings? Then they would have to write out their opinions in a convincing way to have influence.	Mixed
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: In the few cases where panels were used, these were appropriate and conscientious.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The documentation in the jacket was very complete and supported decisions made by the Program Officer. Program Officer reviews were very deliberate and provide a detailed analysis of all components of the	Yes

decision-making process. The program directors did a great job in explaining the rationale for the decisions. i) In ARRA cases, reversals of decisions to fund were appropriate including taking into consideration the potential transformative nature of the proposal in one case. ii) In ARRA cases, reversal of decision was supported by documentation.	
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: Because the reviews were in most cases quite complete and comprehensive, this is the best source of feedback to the PI. However, more guidance could be given when the NSF has specifically considered one criterion over another in their final review analysis. It might also be useful to provide a summary of the review analysis for PIs whose proposals were declined. Sometimes there was no indication of PO comments or diary notes in the communications section, and we recommend that they be provided in all cases.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The ASC has exceeded expectations in this category.	Yes
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process.	

b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

a) In most cases the merit review and actions of program officers were well reasoned and well documented. In a small number of cases, we believe that there were too few reviews. This was particularly critical in the cases where several reviews were determined to be non-substantive and were discounted.

In a few cases, too many declines for reviewer requests by senior experts in the field led to a group of reviewers that was not representative of the peers.

b) ARRA decisions seemed to be well managed.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

Selection of Reviewers	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[3]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The reviewers were representative of the applicant pool, and an appropriate number of reviewers were solicited, given the low response rate. The expertise of the reviewers was well matched to the proposals. However, in a few cases, senior experts were missing due to declines on invitations to review.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: It appeared that the gender distribution was appropriate but we were unable to determine the mix of other underrepresented groups. There was an appropriate mix of regional and institution type.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate?	Yes

[3] If "Not Applicable" please explain why in the "Comments" section.

Comments	
4. Additional comments on reviewer selection: The process would benefit from a somewhat larger fraction of senior leaders in the field as reviewers. Every proposal should have a mix of reviewer experience and areas of expertise.	

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE, NOT APPROPRIATE[4], OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program. Comments: The top people in the field are supported by this program. Proposals that were funded were deemed to be of high quality and at the leading edge of these disciplines. This research portfolio has the potential to greatly impact several of MPS Grand Challenges. This portfolio has some of the most promising and timely research efforts within the NSF from the standpoint of addressing the nation's priorities for research (energy, environment, nanotechnology, and emerging analytical chemistry, etc).	Excellent
2. Does the program portfolio promote the integration of research and education? Comments: In this regard, the program is exemplary. The integration of research and education is especially effective in the RUI grants. We are impressed by the degree of commitment, creativity and thoughtfulness that went into this aspect of the proposals. The CAREER program and broader impacts have changed the culture to integrate research and education.	Yes

[4] If "Not Appropriate" please explain why in the "Comments" section.

3. Are awards appropriate in size and duration for the scope of the projects? Comments: Generally the NSF grants throughout the division are too small to achieve optimal impact and sustainability. Additionally, four years would be a better match to the student academic cycle. We would like to see larger grants, but not at the expense of the number of awards made. Four year awards would also reduce the reviewer burden. Also, Special Creativity Extensions are a useful mechanism.	No
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: There is a reasonable balance of innovative/potentially transformative projects given other programmatic constraints. The innovative measurement tools being developed with ASC support are transformative broadly across the sciences, providing enabling technologies for biology, medicine, materials science, geology, astronomy, energy, and the environmental sciences More risk in the portfolio could be beneficial – the NSF review process is risk averse, the POs have demonstrated willingness to take risk.	Mixed
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The cutting edge of measurement science is multidisciplinary, and the program portfolio properly reflects this. Good mix – energy, nano, separation science, surface science, electrochemistry. Analytical and Surface Chemistry is inherently multi-disciplinary. Program Officers seemed especially focused on program balance and orientation towards new areas and investigators.	Yes
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments:	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators?	Yes

ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: This program seemed to have a significant proportion of new PI's	
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments:	Yes
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments:	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments:	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Ideally, the program should have a larger number of PIs from underrepresented groups, however the current success rate is comparable to rest of CHE, and to the proportion of such PIs that apply.	No
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: Investigators in the area of analytical measurements have long valued the need to address national priorities, including sustainability, health, national security, and economic competiveness. Training in this area represents a critical component of workforce development.	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: The program is actively and thoughtfully managed with good continuity and a high level of expertise. The program has benefited from the stability that results from a larger permanent staff.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The program is responding appropriately to emerging areas and opportunities when appropriate proposals are submitted.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The innovativeness and impact of the research is aptly considered in developing the portfolio.
4. Responsiveness of program to previous COV comments and recommendations. Comments: Excellent – the PO addressed issues from the 2007 COV. Annual updates were informative and responsive. The larger staff and the thorough review analyses reflect careful attention to the previous COV comments.
5. Additional comments on program management: Excellent – the presentation by the PM was highly informative with respect to the review process and the technical content of the portfolio. The committee is impressed with the highlights collected for 2007-2009 to illustrate the breadth and quality of the program. The ASC staff is uniformly exemplary.

Date of COV: May 3 – 5, 2010
Program/Cluster/Section: Inorganic, Bioinorganic, and Organometallic Chemistry
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: **Awards: 15** **Declinations: 12** **Other: N/A**
Total number of actions within Program/Cluster/Division during period under review: 750 **Awards: 219** **Declinations: 531** **Other: N/A**
Manner in which reviewed actions were selected: Program Directors selected 4 clear awards, 8 awards in the "decision interval," 4 declinations in the "decision interval" and 2 clear declinations. The Chemistry Division Information Technology Specialist selected 5 proposal records randomly (1 award and 4 declinations). Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. During the meeting, the COV requested four additional files representing awards made on proposals with low mail review ratings. These files were screened for potential COIs and then made available to non-conflicted COV members for the remainder of the meeting.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[5]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Overall, the processes used for reviewing the variety of different projects in the program portfolio was reasonable. The POs spend quite a bit of effort tracking down appropriate reviewers for proposals. NSF should consider developing a more "intelligent" reviewer database that enables more effective tracking of reviews, ID of reviewers, tracking COIs (similar to what is used for journal editors – there will be a cost associated with this). Such a system would help rotator POs with learning the community more effectively/efficiently. It would also enable POs to respond quickly to ad hoc or panel reviewer needs. The yields of reviews from our community was poor; both the quality is not consistent and the response rates are not in keeping with professional expectations. A revised database could be reflective of journal editor systems that include opt-in/out responses for quick feedback as well as critical suggestions of reviewers (e.g. 5). PO's jobs are made more difficult by having low-quality/non-existent reviews.	Yes, with reservations
2. Are both merit review criteria addressed a) In individual reviews? Generally, yes, but quality varies from simply repeating sections from the proposal summary to more in-depth analyses. Very inconsistent among ad hoc reviewers. The BI sections are not generally reviewed in-depth or as needed. If training of students is de facto part of the role of faculty, a mentoring plan should be developed.	A. Yes, generally B. Yes, generally C. Yes

[5] If "Not Applicable" please explain why in the "Comments" section.

b) In panel summaries? Generally, yes. c) In Program Officer review analyses? Yes Comments: It would be helpful to PIs and reviewers to revisit the dear colleague letter from several years ago that spelled out expectations so that there was consistency in BI statements and reviews. The two merit review criteria appeared to be addressed in the review summaries, but often to different extents, with some providing more detail than others, and in some apparently in disagreement with the reviewers' comments.	
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: Some reviewers are thoughtful and others are much lower quality in what is described/reviewed. 2-3 sentences are not an acceptable review. We need to think creatively about how to encourage better (in some cases any) reviews from the community. This speaks to a need to find a way to positively motivate/reward reviewers. Reviewers in many cases are not justifying their rankings in the discussion and this diminishes the value of the ranking. Although reviewers should be aware of this, it may help to emphasize that the review text is heavily relied upon by the POs.	Sometimes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: While we reviewed only a few of these, the summaries were consistent with the tenor of the reviewers' comments.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions?	Yes, generally

Comments: Generally, the documentation is complete and supports the outcomes. In some cases, the Analyses were repetitive. However, It was noted by the group that there were inconsistencies in the handling of a few decisions. In the instance of the reversal of a consensus of an IBO meeting where the PO wishes to reverse the recommendation, the COV urges that the IBO reconvene to ratify the decision. These inconsistencies appear to be the exception rather than the rule for a group of professional program officers.	
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: During the timeline that the PO comments are available to the COV, we noted that in many cases the rationale for funding and for declines was very carefully articulated and the reviews were carefully summarized. In some the PO went to extra lengths to assess information such as overlap to which the reviewers did not have access. However, this did not appear to be uniformly pursued.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: IBO appears to be at or above the expectation. It would be appropriate to consider mechanisms to streamline the process that would be beneficial to all parties, especially the applicant.	Yes
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. It is unfortunate that there are two windows instead of three, since a decline in proposals usually comes too late to submit for the next round. With three windows, a PI would miss one round deadline but probably would receive the reviews in time to submit for the second.	

A three window system might also free up the POs from being deluged twice a year, and would even out the workload b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? In the case of one ARRA proposal that was resurrected, there was ample documentation to support the decision to fund after a decision was made to not support it.	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[6]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Reviewers who were selected appeared to have the appropriate level of expertise, but the quality of reviews varied. Some proposals would have benefited from reviewers with more in-depth expertise in the area being reviewed. Lack of industrial and/or national lab reviewers was noted. A more high-level reviewer database system would be very valuable.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and under-represented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Appeared to be balanced with respect to the community. Could use more industrial chemists' perspectives. The use of more junior reviewers is to be commended.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: It was difficult to ascertain – our conflicts were recognized.	Not sure
4. Additional comments on reviewer selection:	

[6] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[7], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Excellent overall. There was a broad diversity of projects but the quality of work supported appeared to be appropriate. The only "education" projects observed were in the CAREER program and these appeared to be good.	Yes, excellent
2. Does the program portfolio promote the integration of research and education? Comments: What chemistry/engineering/sciences faculty members do in the academic community is, by definition, integrating research projects with UG/Grad/PDF education. It is integral to the preparation of future chemical professionals.	Yes
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Programs should be longer, a bit larger (given #2 above, NSF should support student research assistantships to allow students to complete their projects to improve student retention/completion). It is difficult to accomplish transformative science with the current levels of funding.	No
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: Yes, the program has done an effective job at identifying transformational science early. History has shown that transformative science has come from funding exceptional basic science, which is clearly the case for the portfolio of the IBO.	Yes

[7] If "Not Appropriate" please explain why in the "Comments" section.

5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Yes, the balance of what was seen was appropriate.	Yes
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Yes, it appeared that IBO projects were primarily single investigator awards.	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: Yes and it is commended that ARRA funding was used to add to this number.	Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: There appears to be an appropriate balance.	Yes
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: There appears to be an appropriate balance among institution types.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: Appropriate balance.	Yes
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Data suggest that there is parity between male/female applications. While URM funding appears to be more proactive, the data are not statistically relevant.	Yes

12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: Teaching/education and research portfolio is consistent with Mission.	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding? Appropriate	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: In general the COV members thought that the management of the program was outstanding, and that the program officers take their jobs very seriously and try to do the best they can with limited funds. For the few exceptions refer to specific answers to questions above.
2. Responsiveness of the program to emerging research and education opportunities. Comments: Seems appropriate but the data are limited. The community's use of the SGER/EAGER grants was limited.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: Portfolio has reflected the general organization of CHE. Reorganization is appropriate.
4. Responsiveness of program to previous COV comments and recommendations. Comments: The reorganization was a response to the previous recommendations and the strategic plan also responded to the comments.
5. Additional comments on program management: Overall, the program POs have responded well to the additional proposal pressures.

Date of COV: May 3 – May 5, 2010
Program/Cluster/Section: Organic and Macromolecular Chemistry
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: 23 **Awards: 13** **Declinations: 10** **Other: 0**
Total number of actions within Program/Cluster/Division during period under review: 1168 **Awards: 349** **Declinations: 819** **Other: N/A**
Manner in which reviewed actions were selected: Program Directors selected 4 clear awards, 8 awards in the "decision interval," 4 declinations in the "decision interval" and 2 clear declinations. The Chemistry Division Information Technology Specialist selected 5 proposal records randomly (1 award and 4 declinations). Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. The COV panels did not request additional proposals for the review.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[8]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The panel review method had some advantages. There was more consensus about the importance of the science and the conclusions were not final until after the panel although the discussion may not be reflected as clearly in summary. The shift to panel-only reviews (without any mail-only reviewers) is a concern. It is important to have adequate expertise on panels to ensure that each proposal receives a sufficiently detailed review. Although the COV recognizes advantages to panels, care should be taken to make sure that this does not result in uneven knowledge of the scientific quality of the proposals under review. Inclusion of ad-hoc reviewers who are experts in the necessary field is encouraged. Reviewers could self-report their expertise level in the subject area of the proposal. The applicants who received mail-only reviews may have an advantage because they can suggest reviewers who are knowledgeable in their research area.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries?	Yes, Yes, Yes

[8] If "Not Applicable" please explain why in the "Comments" section.

c) In Program Officer review analyses? Comments: Both are addressed, but they are weighted inconsistently, particularly for the broader impacts section. The broader impacts are evaluated both in terms of scientific outcomes and educational outcomes. In general, the intellectual merit is weighted more heavily, partly because the definition of "broader impacts" seems to be particularly subjective. The panel review gives a better consensus on broader impacts.	
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: Although many provide helpful reviews, some reviewers provide short reviews that provide little justification for the final evaluation.	Yes/No
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments:	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The COV commends the program officers for being thorough on their Reviewer Analyses, which are particularly helpful to document decisions. The combination of the panel summary and review analysis provides strong justification for funding decisions. One concern of the COV is that when the scientific merit and broader impacts of two proposals are similar, the specific reason for a funding decision should be articulated better; otherwise it appears that the balance of scientific impact and	Yes

broader impacts were weighted on a case-by-case basis. ARRA: CAREER proposals, RUI, EAGER, and proposals from URM PIs were funded by ARRA, which the COV found appropriate. The use of these funds to reverse borderline decisions for junior PIs is commended.	
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The PO Comments section was not found in all cases, and when they did appear, they are often short and not illuminating. The panel summaries are helpful, but in the case of only written reviews, there is no analogous mechanism.	Yes/No
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: Yes in 2007 and 2008. In 2009, except for the need to table responses while waiting for ARRA funds, the goal would most likely have been achieved.	Yes
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? The detailed analysis of the reviewers' comments by the program officer (the Review Analysis) was very useful. This analysis is particularly useful when the written reviewers' comments do not correspond with the score given by the reviewer. Because during panel reviews, panelists are able to modify their previously submitted	

rankings, it is important that the final review text is changed to reflect the new ranking. It may be useful for the panel summary to provide a "panel ranking" independent of the ranking derived from the scores of individual reviewers.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[9]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Most of the time. Yes for mail reviews, but there are concerns from the COV with regards to panels (see question 1). It is very difficult for a panel alone (without ad-hoc reviewers) to have the appropriate expertise to judge all of the proposals in the panel. The expertise of POs, especially those who are permanent, are viewed positively by the COV, since they provide valuable knowledge of the reviewer base and community. The program officers spend a considerable amount of time getting written reviews, however. They should continue to find efficiencies in the reviewing process.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and under-represented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The involvement of a number of reviewers from RUI's would be helpful to get a representative picture across the types of academic institutions.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	N/A

[9] If "Not Applicable" please explain why in the "Comments" section.

4. Additional comments on reviewer selection: It appears that the return on mail-only reviews was low compared to other CHE programs. It would be appropriate that if an individual were not available to review, then having other scientists review their work does not seem equitable. It would be helpful to follow the model of ACS journals and have some mechanism for getting reviewers to agree or not agree to review. Industrial chemists and scientists from national laboratories were under-represented in the review process.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	**APPROPRIATE, NOT APPROPRIATE[10], OR DATA NOT AVAILABLE**
1. Overall quality of the research and/or education projects supported by the program. The projects seemed to be of high quality.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: Education and research are interlinked in the sample of projects reviewed by the COV.	Yes
3. Are awards appropriate in size and duration for the scope of the projects? Comments: There need to be larger awards for longer duration. The cost of doing research has increased. The COV believes that the funding of a grant should be able to fund two graduate students or a postdoc and a graduate student; current funding levels are ~25% below this mark. Longer awards, particularly to RUI's, would not only provide more continuity to the researcher, but it would also reduce the reviewer burden.	No
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects?	Yes

[10] If "Not Appropriate" please explain why in the "Comments" section.

ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The range of projects was quite diverse. We only saw two ARRA awards, so we cannot comment on the balance.	
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Most are single-investigator awards; this is deemed appropriate by the COV.	Yes
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments:	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: We did not have sufficient information to evaluate this question.	N/A
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments:	Yes
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments:	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments:	Yes

11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: This question needs to be better defined. How is “appropriate” judged? Based on demographics, or based upon the number of potential PI’s? The pool of applicants is judged to be low by the COV; however, it likely parallels the demographics in academia. The percent success promotes diversity.	No/not enough data in one portfolio
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments:	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding? The quality of the projects is high. Even many meritorious proposals are unfunded. The range of proposals represents a broad range of research in important areas. A mechanism to evaluate the impact of the portfolio would be appropriate.	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: The COV is concerned about the increased work level required of the program officers as proposal pressure increases. The current workload of the POs is not sustainable with respect to maintaining the high quality of the review process and the confidence of the community. The increased workload in 2009 defined the limits of the system and represented a serious breaking point in the process. The allotment of the budget between dynamics and synthesis is not clear. There should be some detailed plan in place to allot these resources. Proposal pressure is probably not sufficient to determine where resources go.
2. Responsiveness of the program to emerging research and education opportunities. Comments: Restructuring the divisions was a good idea. The EAGER adds another level of responsiveness to emerging opportunities, although these grants should have some level of peer review.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:
The responses to previous COV comments on the development of Strategic Directions for the division and the inclusion of the PO Comments to PIs to provide better communication were addressed adequately. Instead of increasing the number of permanent POs, the number went down in this Program (from six to four). More permanent POs need to be added in the future to meet the suggestions of the previous COV review.

Concerns regarding the nature of the Broader Impacts and its assessment raised in the previous COV remain. This aspect of review needs to be implemented consistently. Research in Chemistry generally involves education of students and postdocs, which provides a significant societal benefit of the technical program in addition to advancing scientific knowledge. Broader Impacts activities that go beyond the training activity and societal benefit, such as outreach programs, should be considered in the award budget.

The COV recommends a systemic and long-term investigation of the usefulness and activities to be taken in the Broader Impacts and assessment of their impact.

5. Additional comments on program management:

Date of COV: May 3 – May 5, 2010

Program/Cluster/Section: Physical Chemistry

Division: Chemistry

Directorate: Mathematical and Physical Sciences

Number of actions reviewed: 31
Awards: 20
Declinations: 11
Other: 0

Total number of actions within Program/Cluster/Division during period under review: 1020
Awards: 307
Declinations: 713
Other: N/A

Manner in which reviewed actions were selected: Program Directors selected 4 clear awards, 8 awards in the "decision interval," 4 declinations in the "decision interval" and 2 clear declinations. The Chemistry Division Information Technology Specialist selected 5 proposal records randomly (1 award and 4 declinations).

In addition to the above, the Physical Chemistry Program selected one clear award as an example of award processing under the American Recovery and Reinvestment Act of 2009 (ARRA).

Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI.

During the meeting, the COV members of the first PCHEM read requested five additional files representing actions on proposals from high profile scientists. The second read group asked some questions regarding program response to proposals that review exceedingly well, and awards that were made for proposals which garnered summary ratings less than 4.00. As a result of these questions, two more proposals were provided. In all, seven proposals beyond the original 24 were made available for COV inspection. As in the case for the original 24, these were screened for potential COIs and then made available to non-conflicted COV members for the remainder of the meeting.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[11]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Combination of individual reviews and panels seem appropriate, but panels should be carefully chosen to ensure the appropriate expertise (breadth and depth) is represented in the panels to review the diverse fields of science represented in EPC and TCC. Panels were used primarily for theory and computational proposals.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: Both merit review criteria are addressed appropriately; however, the community needs to be encouraged to adequately address broader impacts. There is clear evidence for certain borderline proposals that broader impact was a clear offsetting factor for weaker intellectual merit.	Yes, Yes, Yes
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The quality of responses is highly variable. However in all cases, the proposal evaluation relied on receipt of at least three substantive reviews.	

[11] If "Not Applicable" please explain why in the "Comments" section.

4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Some panel summaries were inadequate. Frequently, the panel summaries were brief and did not provide added value to the written reviews.	
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: The Review Analyses authored by the Program Officers were very detailed and provided sufficient rationale to understand the decisions to award/decline. We reviewed only one reversal based on the availability of ARRA funding. The decision to reverse the declination and make this CAREER award was well rationalized. Other ARRA funding decisions were not reversals of earlier decisions.	Yes, Yes, Yes
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The PO comments provide useful feedback to PI and their continued implementation is recommended. This could be improved in some cases, especially with regard to transmitting information on what factors involve intellectual merit and broader impacts.	Variable

7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: In 2008, the percentage was below 70%. This puts an undue burden on PIs with respect to maintaining the continuity of research programs. We recognize that some delays may be due to the lack of response to requests to review. To assist PIs in identifying reviewers, we recommend that PIs be required to submit a list of suggested reviewers for each submitted proposal. Time to decision was also not appropriate in 2009 due to ARRA funding. However, the present set of program managers continue to be over stressed and an additional program director is justified base on the needs of physical chemistry and theory.	

8. Additional Comments

a) Additional comments on the quality and effectiveness of the program's use of merit review process.

In limited cases, other considerations beyond merit review were factors in making some funding decisions, e.g. other support. Perhaps these issues should be addressed with the PI before peer review, and as appropriate after peer review.

b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

We reviewed three ARRA-funded jackets: Two were funded in this manner because they addressed areas of national priority (sustainability and new investigators), and the third because it expanded infrastructure. Thus the rationale was highly appropriate..

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[12]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: In general, the reviewers were well-matched to the subject area of the proposal under review. There were a few cases where the choice of a subset of the reviewers was sub-optimal but this was offset by the expertise of the other reviewers., Sometimes only 3 reviews were obtained.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and under-represented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Choice of reviewers reflects diversity and balance in all of the above areas. Comments:	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: No conflicts of interest were apparent in the jackets we reviewed.	N/A
4. Additional comments on reviewer selection: We are concerned that it may be difficult to assemble panels with sufficient depth and breadth to critically review some proposals in highly-specialized areas.	

[12] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[13], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: What's funded is excellent, but many excellent programs are unfunded due to budget constraints including equipment needs.	Excellent
2. Does the program portfolio promote the integration of research and education? Comments: Excellent integration of research and training of the next generation of scientists.	Yes
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Not enough awards funded and the award size is generally insufficient to address critical national priorities in energy, environment, biomedicine, and materials (as examples). Small awards tend to favor conservative research, and limit efforts to conduct high risk, transformative research.	Yes
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: EPC and TCC have traditionally been highly innovative programs. To ensure this trend, funding levels need to be increased. Limited funds inhibit risk-taking. Funding for outstanding research in the core of the discipline is essential. The majority of the funded proposals we reviewed represent excellent basic science that is not claimed to be transformative. This is proper; while some mechanisms for transformative research should be in place, there is a danger of funding trendy and weak research in the name of transformative. Most advances in science come from multiple scholarly and thorough investigations. This type of research should remain the main emphasis of the program.	Yes

[13] If "Not Appropriate" please explain why in the "Comments" section.

5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Many EPC and TCC are single investigator awards, but impact broadly in many disciplines including biomedical, physics, energy, environment, and materials.	Yes
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Primarily single investigator awards, although many collaborations are evident in these programs (e.g. experiment and theory). A few large programs were cut in size to fund more proposals. While undesirable, this was a necessary consequence of funding constraints.	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? CAREER awards are a high priority in terms of success rates; this is appropriate. ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? Number of CAREER awards was increased substantially as a result of ARRA funding. NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments:	Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The best science is being funded and awards are broadly distributed geographically.	Yes
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: It appears that proposals from non-PhD granting institutions are given appropriate consideration.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity?	Yes

Comments: Yes, a broad range of activities is funded that is representative of the most innovative science in the field, which is ever increasing in breadth and diversity.	
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Funding success for underrepresented groups in EPC and TCC over the past three years is comparable or better than that for total awards 29% EPC, 31% TCC overall 34% female 28% underrepresented groups	YES
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The program supports research directed at a wide range of crucial national priorities, including energy, biology, materials and the environment. However, the main focus of the program is, and should continue to be, focused on the core discipline of chemistry.	YES
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: Program is well-managed, but understaffed. This is of articular concern when panels are used to alleviate the workload issues; panels can lead to very different outcomes, and sometimes lack technical expertise when working with a broad range of science. Breadth and depth of expertise lacking in some panels. Better use of funds (instead of panels) may be part-time program managers, including the possibility of off-site program managers in key target areas..
2. Responsiveness of the program to emerging research and education opportunities. Comments: High success rate for SGER and EAGER awards, but small total funds allocated. Program effectiveness should be evaluated.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: Prioritization is appropriately responding to ideas that originate in proposals.
4. Responsiveness of program to previous COV comments and recommendations. Comments: Very responsive: reorganized programs, strategic plan, increased permanent staff, and introduction of PO comments to PIs.
5. Additional comments on program management: PI should have the opportunity to respond to NSF concerns regarding potential overlap with other funding sources. We saw one example and have heard anecdotally of others where highly reviewed innovative science is not funded due to its being too closely related to work funded elsewhere. In view of the fact that a typical NSF grant is insufficient to fully support a program or progress in an area, NSF should be open to leveraging its resources to have a greater impact. If this is not possible, this needs to be made clearer to PIs, so that they can either decide not to expend their effort on proposal resubmission or can articulate more clearly the distinctiveness of the proposed work.

Date of COV: May 3 – 5, 2010
Program/Cluster/Section: Centers
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: 28 **Awards: 14** **Declinations: 6** **Other: 8**
Total number of actions within Program/Cluster/Division during period under review: 34 **Awards: 12** **Declinations: 22** **Other: N/A**
Manner in which reviewed actions were selected: A combination of 26 awards and declinations from both Phase I and Phase II of the Centers for Chemical Innovation Program were selected; preliminary proposals and proposals in the decision interval were considered. Program Directors selected the sole Science and Technology Center (STC) and Nanoscale Science and Engineering Center (NSEC) awards in the Division. Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. The COV panels did not request additional proposals for the review.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[14]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The close evaluation of proposals and award through various stages of consideration and award is important and is encouraged. The Division is doing an excellent job in executing the careful evaluation of proposals and projects at various stages. A very appropriate mix of panels and site visits is employed. With panel reviews there is always the issue of having adequate technical expertise to provide in-depth review of all aspects of all proposals. Obviously, the problem is more severe the smaller the panel and the broader the expansion of activities covered in the proposals. Given limited resources and given the complexity of Center proposals, the Division is overall addressing this issue more than adequately. The use of panels is appropriate in Phase I. We questioned whether having only three reviews in Phase I was adequate given the size of the investment. Perhaps the Phase I review can be augmented with mail review.	Yes
2. Are both merit review criteria addressed a) In individual reviews? Inconsistently b) In panel summaries? Consistently, but pro forma c) In Program Officer review analyses? Consistent attempt at thoughtful evaluation	Yes

[14] If "Not Applicable" please explain why in the "Comments" section.

Comments: The panel summaries in some case appear to be *pro forma* in regard to the Broader Impact criterion. Compared to single investigator research proposals, the center proposals more uniformly address both criteria and as such may be providing training of the community in this process.	
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: There is considerable variability from both reviewer to reviewer and from panel to panel with respect to substantive comments.	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The summaries seemed to provide a consensus of the written reviews.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? Yes *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Yes Comments: Disparity in ratings: For the three funded Phase II proposals they ranged from 7 E's and 5 V's to 4 E's, 2 V's, VG, G, and G/F. This spread in the ratings might not be unusual for an emerging program at NSF, however in future rounds of funding these disparities should be addressed.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: There is some variability, with somewhat less detailed responses occurring mostly when the Center review process was in its formative stages. There has been increased emphasis with respect to feedback provided over the past three years and this emphasis is very important and should be continued and strengthened when possible.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments:	Yes
8. Additional Comments Additional comments on the quality and effectiveness of the program's use of merit review process. The Centers Program is new at NSF; the staff at NSF has done a good job in the launching of the Centers Program. To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[15]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: As noted above, the finite size of panels and the broad nature of Center proposals make it difficult to provide in-depth technical expertise to cover all aspects of all proposals being considered by a panel. Given resource limitations, the program has done an excellent job of selection of reviewers. Greater participation from leading/ senior people in the fields would be desirable.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments:	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	Yes
4. Additional comments on reviewer selection:	

[15] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[16], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Overall Centers make a very important contribution to the portfolio of research supported by the Division. The awards in the centers category are largely in support of scientific investigations and the development of human resource through research rather than a broader educational mission. The overall quality of the research accomplishments is excellent for the Phase II efforts. There are still few points of evidence that the Centers are greater than the sum of their parts.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: There was not as much evidence as we would expect that there is much multi-disciplinary education. The centers are young but advancing, it will be important to track the breadth of student education.	Appropriate
3. Are awards appropriate in size and duration for the scope of the projects? Comments: There is an appropriate relative weighting of funding and duration between Phase I and II of CCI awards.	Appropriate
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects?	Appropriate

[16] If "Not Appropriate" please explain why in the "Comments" section.

Comments: The number of proposal funded in 2009 was five; this is not enough to see an impact. Some of the proposals currently in Phase II were viewed as conservative whereas some of the proposal in Phase I were viewed as more innovative.	
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Some Centers are not currently multi- disciplinary being focused within the subdisciplines of Chemistry. Greater participation from other disciplines would benefit some of the CCIs.	No
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The Centers Program focuses only on multiple investigator award.	Not applicable
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: In general as expected, Center proposals are lead by senior more established investigators but younger investigators frequently appear as co-PIs. We view this positively as it can provide important mentoring of younger scientists.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments:	Appropriate
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: There is very good inter-institutional interaction in the program portfolio, e.g. different types of institutions are involved in many centers.	Appropriate

10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: The portfolio is small but broad.	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: Attention needs to be paid here, participation of women is half the NSF wide average and the participation of under-represented minorities is below half of the average.	Appropriate
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments:	Appropriate
13. Additional comments on the quality of the projects or the balance of the portfolio: The quality of the projects is very high and makes a clear case for the importance of Centers in the Division's portfolio. ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding?	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: This is a well-managed program and the staff is be commended on the very successful implementation of this new activity of the Division. NSF management has been effective. Internal management of the Centers by the PI is not uniform.
2. Responsiveness of the program to emerging research and education opportunities. Comments: NSF-CHE has been very responsive to emerging opportunities for scientific progress in research and education. In part pro-activeness toward opportunities is the reason for the center proposals. These are big problems that require cross-disciplinary collaborative efforts to reach solutions. Because traditional disciplines have been merging at their interfaces, potential problems are now tractable only with strongly collaborative efforts. The best way for these problems to be tackled is to have individuals gather groups and submit ideas to the NSF.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: Program planning and prioritization has been very effective, particularly given the historical focus of Chemistry on single investigator funding. The program and Division Director have done an effective job of educating the community on the rationale for Center funding in the Division's portfolio.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: This program was just being implemented at the time of the previous COV. The program has been responsive to previous COV comments and recommendations. The Division has been sensitive to the concern of the COV that Centers not be implemented to the detriment of the single investigator program.

5. Additional comments on program management:

CCI is a developing program and the program officer needs to have enough latitude to discontinue awards that are not performing and evolving the program in general.

Date of COV: May 3 – May 5, 2010
Program/Cluster/Section: Education
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: 15 **Awards: 8** **Declinations: 7** **Other: N/A**
Total number of actions within Program/Cluster/Division during period under review: 267 **Awards: 94** **Declinations: 173** **Other: N/A**
Manner in which reviewed actions were selected: Program Directors selected 3 clear REU awards, 3 REU proposals in the "decision interval," and 3 clear declinations from the REU Program. Four proposals were selected from the ACC-F Program along with two special project actions. Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. During the meeting, the COV requested two additional proposals representing submissions from primarily undergraduate institutions. These proposal files were screened for potential COIs and then made available to non-conflicted COV members for the remainder of the meeting.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[17]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: REU: Panels are appropriate for review of this program ACC-F: Panels are appropriate for review of this program.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: REU: The criteria are often addressed in an uninformative way and at a very cursory level in individual reviews. It is not apparent from the reviewers' comments that reviewers are aware of how to assess each criterion and often defaulted to focusing on broader impacts. Panel summaries are generally a reflection of individual reviews and thereby do not shed much additional light on the proposal's quality or shortcomings. When a panel summary differs markedly from the individual reviews, the variance in the individual reviews and panel summary is not addressed. One way to improve the quality of the panel summary is for the Program Officer not to accept the panel summary until the summary is written in a clear and substantive way. We did find that the Program Officer review analysis was generally clearer and more to the point than the panel summary. ACC-F: Yes	REU - No ACC-F - Yes

[17] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: REU: No. Most often the individual reviewers highlighted text from the proposal as opposed to providing a true assessment of how the proposal addressed the criteria. Some do not seem to support the ranking they assigned. In other cases the written comments were at odds with the ranking. ACC-F: Yes	REU - No. ACC-F - Yes.
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: REU: While the 2008 panel summary pages had a section labeled "Rationale for Panel Ranking", the comments generally did not reflect fully why a proposal was recommended or not. The depth of the summary needs to be enhanced. ACC-F: Yes	Yes and No.
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: No reversals apparent. REU: In most cases, only by reading the review analysis was the rationale for the award decision apparent. When the ranking of individual reviews is clearly different than the overall tenor of the panel summary, it would be helpful for the panel summary to indicate this. The recent implementation of Program Officer comments will lessen the need for this step, but proposers will benefit from understanding why their review rankings are not in sync with panel summaries. ACC-F: Yes	Yes, but only by reading the review analysis.

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: REU: As noted in #5, the introduction of the PO comments should help in this regard. ACC-F: Yes	REU - Not always. ACC-F- Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: REU: 2008 – commendable. This timing should be applied in future REU awards. The time to decision slipped in 2009, and the REU solicitation was too late in 2010. Pressing REU engagements of PO prevented maintaining timeliness. ACC-F: Yes	Yes
8. Additional Comments a) Additional comments on the quality and effectiveness of the program's use of merit review process. b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding? REU: Panelists generally have a non-uniform understanding of evaluation criteria. This has the possibility that extremely worthy proposals will not get funded. Furthermore, applicants do not give the appropriate information that they need to improve their proposal for resubmission.	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[18]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: REU: Yes and no. Some reviewers were less aware of the science and capable of reviewing the broader impacts; others were well positioned to handle the intellectual merit criterion but had less appreciation of the broader impacts. ACC-F: Yes	REU: Yes and no. ACC-F: Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and under-represented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. REU: With the small number of panelists the distribution of reviewers seems reasonable. In one REU case the reviewers were all from the same geographic region. ACC-F: Yes, as much as was possible due to size of the panel.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: REU: NA ACC-F: NA	NA
4. Additional comments on reviewer selection: REU: A uniform # of reviewers is recommended not just 2 (and preferably more than 3).	

[18] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[19], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: REU: One way to assess the quality of the program would be a longitudinal study of the participants' ultimate career path. In REU, more money would make it possible to support more EXCELLENT programs. ACC-F: Analysis provided in the diary supported this point.	REU - Data not available ACC-F - Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: REU: One way to assess the quality of the program would be a longitudinal study of the participants' ultimate career path. ACC-F: Yes	REU - Yes ACC-F - Appropriate
3. Are awards appropriate in size and duration for the scope of the projects? Comments: REU: Yes – aiming for 10 students ACC-F: Yes – generous for a postdoctoral award.	Yes
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: REU: NA ACC-F: Yes, there is an appropriate balance of innovative projects.	REU: NA ACC-F: Yes

[19] If "Not Appropriate" please explain why in the "Comments" section.

5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: REU: Yes, the portfolio is overwhelming multidisciplinary. ACC-F: NA - the program is too small to make multidisciplinarity a goal.	REU: Yes ACC-F – NA
6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: REU: NA ACC-F: NA	NA
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: REU: The awards are primarily to established investigators, and it is appropriate to direct funding toward experienced investigators. REU sites are evolving appropriately - there appears to be a good mix of new REU sites with established sites. ACC-F: Yes	REU - NA ACC-F - Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: REU: Yes ACC-F: NA	REU: Yes ACC-F: NA
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: REU: Liberal arts institutions appear to be underrepresented. ACC-F: NA	REU - No ACC-F - NA

10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: REU: Yes ACC-F: NA	REU: Yes ACC-F: NA
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: REU: One of the strengths of this program is the focus on underrepresented groups ACC-F: Yes	REU: Yes ACC-F: Yes
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: REU, ACC-F, Special Projects: YES. REU's are important to recruiting future scientists; ACC postdocs specifically focus on this, the examples show that this is working. America COMPETES Act http://science.house.gov/legislation/leg_highlights_detail.aspx?NewsID=1938 National Academy of Sciences' "Rising Above the Gathering Storm," http://www.nap.edu/catalog.php?record_id=11463 National Research Council's "The Future of U.S. Chemistry Research: Benchmarks and Challenges" http://books.nap.edu/catalog.php?record_id=11866 National Science Board's "Research and Development: Essential Foundations for U.S. Competitiveness in a Global Economy." http://www.nsf.gov/statistics/nsb0803/nsb0803.pdf	REU, ACC-F, Special Projects: Yes.
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding? ACC-F: Too small a program to evaluate the balance of the portfolio. The proposal competition is deemed to be worthwhile, and a longitudinal study of the projects' impact should be conducted before growing the program.	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

REU: We applaud the current multi-year management of the program by a single program officer – this continuity and oversight is exactly what this program needs. We do think the program officer should consider some form of reviewer training to equip reviewer's with the capacity to effectively address both review criteria. There are other NSF programs that conduct effective on-line reviewer training (for example NSF-ADVANCE) to use as models.

ACC-F: Yes, analysis of the program by the program officer is outstanding.

Special Projects: The special projects that the Program Officer has elected to support are entirely appropriate and consistent with the NSF CHE strategic plan.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

REU: The growing number of international REUs is to be commended, especially expanding sites beyond Europe. We especially applaud the recent additional funding for the program overall. However, we are concerned that the expansion to international sites has come at the expense of domestic sites as the number of domestic sites has fallen from 67 to 60 from 2006 to 2009. We believe that the REU program provides our country with an element of national security, drawing American students into STEM graduate programs.

ACC-F: This program speaks directly to the integration of research and education at the forefront of emerging research fields and implementing innovative educational approaches.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:
REU is well-developed, well defined, supported by the community. ACC seems an interesting innovation. Program appears to be open to experimentation with new programs and ideas. Interesting special projects. All educational programs appear to be well managed.

REU: This program is consistent with the Division's strategic plans' highest priorities, particularly "Advancing American Competitiveness".

ACC-F: This program is consistent with the Division's strategic plans' highest priorities, particularly "Advancing American Competitiveness".

Special Projects: The funded projects that we considered directly addressed some of the Chemistry Division's "eight critical issues" as outlined in the Strategic Directions 2008-2012 document, including "Communicating the Value of Chemistry to the Public" and "Broadening Participation". The Program Officer has used the Special Projects designation in a very effective manner.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

REU: The previous COV called for better attention on the part of the reviewers to address the broader impacts criteria. There is a continuing concern regarding balancing the two criteria. We concur with the need for a minimum of three reviewers. We also concur that REU is underfunded, as described above.

ACC-F: In a similar vein to the Discovery Corp fellowships, ACC-F has a particular the focus on American competitiveness and on innovation.

5. Additional comments on program management:

In line with current practice, we would encourage the REU program announcement to state that preference is given to those proposals where there is not already an REU site in existence in the same department.

In reviewing continuing REU programs, publication should not be the principal measure of success; assessment should address the overall student experience, especially with younger and less experienced participants.

Date of COV: May 3 – May 5, 2010
Program/Cluster/Section: Instrumentation
Division: Chemistry
Directorate: Mathematical and Physical Sciences
Number of actions reviewed: 20 **Awards: 12** **Declinations: 8** **Other: N/A**
Total number of actions within Program/Cluster/Division during period under review: 368 **Awards: 108** **Declinations: 260** **Other: N/A**
Manner in which reviewed actions were selected: Program Directors selected 2 clear awards, 4 proposals in the "decision interval," and 2 clear declinations from the CRIF Departmental Multi-User Program. Four proposals were selected from the CRIF Cyberinfrastructure, Facilities, and Instrument Development Programs. Efforts were made to minimize conflicts-of-interest (COI) with COV members. Access was blocked for proposals where a COV member had a COI. During the meeting, the COV requested additional examples of files representing ARRA award reversals and of CRIF instrument development awards/declines from female PIs. Four files from each category were provided. These files were screened for potential COIs and then made available to non-conflicted COV members for the remainder of the meeting.

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[20]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The reviewers felt that the panels that compared similar types of proposals were appropriate and very good; site visit reports were excellent and provided information relevant to funding decision. The combination of ad hoc reviewers and panels seems to be working.	yes
2. Are both merit review criteria addressed a) In individual reviews? yes b) In panel summaries? yes c) In Program Officer review analyses? yes Comments: We did notice that in one incidence, the program officer overrode the panel's recommendation because of the panel's belief that the proposal lacks "broader impact". We note that the PO's try to bring the department plan into the decision on broader impacts.	yes
3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: On the whole the reviews are thorough. However, review detail was mixed ranging from very detailed to cursory; some of the poorly ranked proposals needed more constructive feedback in order to improve.	yes

[20] If "Not Applicable" please explain why in the "Comments" section.

The identification of operators and managers for the instrument was identified as another plus for some applications.	
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Summaries were helpful in effectively distilling the main points of the individual reviewers. However, some panel summaries are short.	yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) During FY 2009, NSF permitted reversal of a declined decision for funding through ARRA for proposals declined after October 1, 2008. (NOTE: This question does not apply to programs for which the reversal decline option was not used.) i) Were the reversals of the decision to decline based on both the high quality* of the reviews received on the initial submission and the lack of available funding at the time the origin was made? *Rated "Very Good or above" or the functional equivalent by review panels. ii) Is documentation provided, including a revised Review Analysis, to support the award decisions? Comments: i. The vast majority of the ARRA's reversals that we reviewed were good investments and has not previously been funded because of inadequate resources. ii. Documentation on revised review analysis is generally very good.	yes
6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: Providing the Program Officer's comments to the PI is definitely an improvement. In cases when the reviews are inconsistent, the PO's decision-making process should be provided to the PI in some form.	yes

7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: Outstanding	yes

8. Additional Comments
   a) Additional comments on the quality and effectiveness of the program's use of merit review process.
   b) To what extent does the documentation in the jacket or otherwise available provide the rationale for use of ARRA funding?

In most cases the panels take the broader impact criteria very seriously; cov generally felt that broader impact is very important in terms of developing the future scientific workforce while also addressing the need for scientific excellence.

The program solicitation for CRIF MU proposals requires a Departmental Plan for Broadening Participation to be submitted as part of supplemental material. This is the only departmental funding program in the CHE portfolio and the only program that requires such a plan. It is not yet a review criterion for funding decisions on these proposals, but some consideration is being given to the broadening plan. At present, reviewers (individuals and panel review teams) are asked to comment on how the acquisition of the new instrument will factor into and/or facilitate the department's plan for broadening participation. The instrument category does not seem like the right place for this.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[21]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Reviewers appropriateness was mixed; for these proposals the reviewers should be more in line with the applicant's institution (i.e. more should come from PhD granting institutions if the PI is at a such an institution).	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and under-represented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The e-jacket does not provide the entire picture so we could not respond to this.	Note sure
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: One of the facility upgrade proposals appeared to have a conflict-of-interest issue, but the reviewer claimed no conflict at the time of review. Upon further investigation, the COV feels the NSF staff acted appropriately, and that no COI actually existed at the time of review.	Yes
4. Additional comments on reviewer selection: For these particular applications, it is important that some of the reviewers come from PhD granting institutions.	

[21] If "Not Applicable" please explain why in the "Comments" section.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[22], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: This is generally a broad and excellent portfolio addressing both state of the art science as well as providing instrumentation for education and training the future workforce.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: We felt that the use of instruments in the educational setting prepares the students for future use in research; in one case the institution planned a future curriculum around the anticipated acquisition of the instrument.	Appropriate
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Yes; annual progress reports are a good tool to monitor the use of the funds.	Appropriate
4. Does the overall program portfolio (including ARRA funded awards) have an appropriate balance of innovative/potentially transformative projects? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of innovative/potentially transformative projects? Comments: The innovative proposals (instrument development) do not fall into this category.	Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: MU instruments serve many different users and many different kinds of science.	Yes

[22] If "Not Appropriate" please explain why in the "Comments" section.

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The balance now is good but in the future instrument development will be moved to another program; innovation in instrumentation will come through creative use of the instrument by the multiple users in their research programs.	Appropriate
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? ARRA Specific Question: Does the ARRA funded portfolio have an appropriate balance of awards to new investigators? NOTE: A new investigator is defined as an individual who has not served as the PI or co-PI on any award from NSF (with the exception of doctoral dissertation awards, graduate or postdoctoral fellowships, research planning grants, or conferences, symposia & workshop grants.) Comments: The MU proposals facilitate the research of new investigators who are not the PI; note that the MU proposals require that the department chair be the PI.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The PO overview documented wide distribution of proposals throughout the country.	Appropriate
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments: Yes; some less research-active institutions were included and the MRI proposals added to the balance.	Yes
10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: The proposals in the portfolio support a broad range of disciplines and science.	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups?	Not appropriate

Comments: Since there is a requirement that department chairs be the PI's of MU proposals, minorities and females are under-represented. The participation of minority groups is increasing, and the efforts of encouraging minority applications should continue.	
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: Yes; training the future scientific workforce is a broad mandate as is training scientists for addressing problems that require multiple disciplines.	Appropriate
13. Additional comments on the quality of the projects or the balance of the portfolio: ARRA Specific Comments: Additional comments regarding the portfolio of ARRA awards addressing the NSF or program-specific priorities for ARRA funding? Major investments in instrumentation were made with the ARRA funding, and this was deemed an excellent use of resources. Increased access to modern chemical instrumentation benefits many users across many types of institutions for both education and research. In addition, one-time spending on instrumentation grants does not create a problem with renewal grant pressure, so this decision to fund instrumentation was sound management.	

A.4 Management of the program under review. Please comment on:

1. Management of the program. Comments: PO's are very experienced; documentation on the decision making process is excellent; turnaround time is superb. In addition FastLane is an excellent management tool.
2. Responsiveness of the program to emerging research and education opportunities. Comments: The funded facilities, CRIF-ID and Cyber proposals all support and facilitate emerging research; however, for the future, the proposals that are left for this section are more routine in terms of instrument innovation. Rather the response to research and education opportunities in the future will come from creative applications in users' research and in education and training for the larger chemistry community.
3. Program planning and prioritization process (internal and external) that guided the development of the portfolio. Comments: The portfolio is responsive to the community, which is appropriate.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:
Better and very constructive feedback to PI's; yearly update of response was good. With the new strategic plan there is optimism that CHE will obtain the high funding which is consistent with its broad contribution to national needs.

5. Additional comments on program management:

We were impressed with the quality and dedication of the PO's and permanent staff.

For the CRIF MU program, the main author should be identified in the list of co-PIs in the proposal.

PART B. RESULTS OF NSF INVESTMENTS

The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

CHE supports fundamental science and discovery in the broad discipline of chemistry for the US. This is not a top-down driven process and projects are not selected based on application area or area of impact. However, out of the diverse portfolio of CHE-funded projects has sprung high impact science in application areas that are identified as critical to national priorities. These are fundamental groundbreaking studies that end up furthering knowledge and pushing discovery in relevant and broadly multidisciplinary application areas. In selecting high impact science from among the abundance of exciting projects within the CHE portfolio, we found that many naturally grouped into these critical and timely topics: Energy, Environment, National Security and Industrial Competitiveness, Chemistry of Life Processes, and Cool Chemistry.

Energy: The energy crisis will have chemistry at the center of its multifaceted solution. Indeed, this was highlighted in the U.S. National Science Foundation Division of Chemistry

Strategic Directions 2008-2012 document. Examples of NSF Chemistry Division supported projects that have made transformative contributions to this area are given in the main body of the report in section B. 1.

Environment: An important strategic goal of the Division of Chemistry involves supporting innovative basic chemical research that has applications in addressing environmental problems. Projects providing examples of how fundamental investigations can lead to important breakthroughs in this area are given in the main body of the report in section B. 1.

National Security (Trace Detection) and Industrial Competitiveness (Catalysis): Chemistry has been enabling in the discovery of new sensors for detection of chemical and biological targets relevant to national security, such as anthrax, bacteria, and nerve agents, as well as new methodologies to decrease the occurrence of false positive detection of these targets. Advances in chemistry have also empowered industrial competitiveness through innovative methods, generally known as catalysts, which increase efficiency and often reduce the waste stream in manufacturing of synthetic fuels, polymers, and other products traditionally derived from the petrochemical industry. Examples are given in the main body of the report in section B. 1.

Chemistry of Life Processes: There is obvious synergy between chemical and biological disciplines particularly when it comes to molecular synthesis, molecular identification of species, and the study of complex multistep reactions. Many of the principles and techniques that have been developed for chemical analysis and are central to the chemical discipline have been leveraged into the biological landscape to enable discovery. This has been recognized in recent years by extensive cross talk and collaboration between the Division of Chemistry and the Division of Molecular and Cellular Biosciences, and is evidenced in some of the program highlights funded by CHE. These are grouped into two areas: advances made in chemistry/materials for biological imaging, and advances in elucidating biochemical processes. Examples are given in the main body of the report in section B. 1.

Cool Chemistry: Often it is difficult to imagine just how impactful fundamental advances in chemistry will be. These discoveries lead to new materials and processes that are used broadly in every area imaginable and support the nation's broad industry sectors. Advances in fundamental chemistry continue to surprise and enlighten scientists, and set the basis for new discoveries. Examples are given in the main body of the report in section B. 1.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."*

Comments: The Division of Chemistry (CHE) funds excellent educational initiatives that address each of the investment priorities for the learning outcome goal in the CHE strategic plan. The Committee of Visitors (COV) recognizes CHE as a leader in establishing new and innovative programs over the years at the National Science Foundation (NSF). For example, the NSF Career Award Program and the Research Experience for Undergraduates (REU) both started in the Division of Chemistry before the programs were instituted Division wide. Addressing the development of a diverse world-class scientific workforce, while

simultaneously promoting scientific literacy for all of the Nation's citizens, is a challenging task. However, CHE has effectively used the NSF portfolio of investments to fund projects that provide programming for the best and brightest individuals who are pursuing careers in chemistry as well as for those citizens for whom scientific literacy is the goal.
Several of the investment priorities for the learning outcome goal are listed in the main body of the report, section B.2, along with exemplary projects that address each priority and the noteworthy achievements resulting from the projects.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.*"

Comments: Modern chemical instrumentation provides sensitive and selective tools for molecular characterization critical to scientific discovery. The development of new tools enables breakthrough discoveries in all areas of chemical sciences. NSF-funded developments in novel chemical imaging, and mass spectrometry instrumentation for field studies of atmospheric aerosols, ion detection, including the recently commercialized Orbitrap, and analysis in an open laboratory environment, enable important new types of chemical measurements. Tools based on molecular spectroscopy using microwave rotational transitions and non-linear optical probes of interfaces have led to advances in trace detection. Optical spectroscopy methods are broadly applicable, with applications ranging from medical diagnostics to explosives detection. Specific examples and award numbers are provided in the main body of the report, section B.3.

Advanced computation and cyberinfrastructure build electronic resources to enhance chemistry discovery, establish virtual communities and provide broad-based access to resources through remote accesses instrumentation. New software and simulation tools create the ability to visualize chemical reactions through movies on a molecular level.

National user facilities such as ChemMatCARS, NHMFL and NNIN provide centralized resources containing state-of-the-art instruments that both serve as a measurement resource for the scientific community and as centers for advanced instrument development.

The Chemistry Division wisely invested a significant proportion of ARRA funds on instrumentation facilities and development which will have a long-term and broad-based impact on scientific discoveries. Ready access to high-field NMR and mass spectrometers and x-ray diffractometers is vital for accelerating new molecular discoveries. Programs such CRIF and MRI fund instrumentation that advance current research, and provides instruction and training for the next generation of scientists at a diverse set of institutions.

PART C. OTHER TOPICS

1. Describe the *trajectory* for CHE supported programs with respect to two major criteria: identification of transformational science and support of broader impacts.

The research supported by the chemistry division is outstanding in quality, and it cuts across many important national priorities, including energy, environment, economic competiveness, health, and national security. NSF supports the basic research that enables the development of applications by other agencies, such as DOE, EPA, and NIH. What is unique about NSF is the integration of research with education, which has the effect of fostering workforce-ready graduates. The high quality of the NSF research relies in part on the strength of the review process. There are two review criteria: intellectual merit and broader impacts. Intellectual merit is universally accepted by the NSF reviewing community as science that has the potential to become transformative, from the original idea through intellectual fruition to societal impact. Investments over multiple grant periods and over many investigators are needed for a given transformative idea to be carried to societal impact.

The inclusion of broader impacts in proposals is valuable because it increases the societal impact of NSF funding. The high quality of broader impacts also relies in part on the strength of the review process. The interpretation of the broader impacts criterion by the reviewing community appears to be problematic because of widely varying interpretations and relatives weight assigned by reviewers and NSF program officers. The chemistry division has done an outstanding job of explaining broader impacts on the CHE website ("Merit Review Criterion: Broader Impacts"). The problem is apparently that the community is not sufficiently aware of this website. We suggest that the chemistry division post a short on-line tutorial for the community, which would include the rationale and anticipated outcomes for the criterion, and the information on the current web page. We suggest also that proposers and reviewers be directed to the tutorial at least once.

2. A. Are the size and duration of CHE awards well balanced given the pressures of proposal numbers and budget allocations? B. Is the distribution of awards between the different funding types (research projects, centers, instrumentation, education, special projects, etc.) appropriate for today's chemistry community?

A. The Division of Chemistry has a diverse portfolio that represents the broad array of research programs and directions in the chemical sciences. However, annual funding of individual grants supported by the National Science Foundation provides proportionally fewer resources, especially for personnel, than in prior years. In addition, there is concern that potentially transformative research may be lost to the NSF because of the current level of funding. Principal Investigators are having increasing difficulty to achieve programmatic aims with dwindling resources. The COV recommends that future increases in funding be used to increase the funding level of individual grants without decreasing the number of individual grants in the portfolio.

B. Centers (CCI, STC, NNIC) have been demonstrated to be an important component of the portfolio of the Chemistry Division, complementing individual researcher grants efforts. They contribute significantly to highlights deriving from Division research, education, and workforce diversity enhancement as well as demonstrating proposals and funded projects of high intellectual merit and important broader impacts. The Centers Program is a nascent effort in the Division, which is still evolving, and requires continued evaluation. However, the

Program Officers are to be commended on their successful initial implementation of the program. The emphasis on improved management, education, and workforce diversity enhancement evident in the STC, NNIC, and phase II CCIs is to be commended and illustrates the effective role that NSF can play in promoting these activities through the Centers mechanism. Centers must necessarily demonstrate performance where the "whole is greater than the sum of the parts" and education, workforce diversity enhancement, and technology transfer are examples of areas where the Centers mechanism affords the opportunity to make unique contributions. The CCI Phase I/Phase II review (proposal/center progression) mechanism provides effective risk mitigation; however, the process may be improved by greater attention to incorporation of education and workforce diversity enhancement in Phase I proposals. Also, the review process for Phase I proposals appears to include only panel review. Because of the small size of the panels and the diversity of the subject matter, it would be beneficial to augment panel reviews with ad hoc reviews by specialists. The current distribution among funding types appears appropriate for today's environment. The planned trajectory for an increase in number of Centers should continue to be supported as these Centers provide a valuable tool for transformative research, education, and workforce development.

3. Overall, are the NSF review mechanisms (ad hoc, panels, cyberconferencing) appropriate and sustainable for the CHE community? What recommendations are there for the future?

The current review mechanisms applied to the broad spectrum of grant types at CHE are appropriate. They allow flexibility to accommodate the demands of each program; however, it was clear that some programs have had to rely on review mechanisms that have not served the community well. Panel reviews are efficient but not optimal for all grant types particularly where there is a broad distribution of science. Nevertheless, it was recognized that Program Officers are challenged with obtaining the appropriate number of quality reviews in a timely fashion that enable them to make decisions.

The COV expressed concerns that the current model of reviewing projects may not be sustainable. The rate of return on reviews is low and Program Officers spend a considerable amount of time managing the review process, identifying appropriate reviewers, and tracking down reviews. As the number of proposals has increased, the Program Officer workload has subsequently increased despite the limited growth of staffing in CHE. In order to ensure the quality of the critical peer review process long-term, additional resources must be considered.

Specifically, the COV recommends the following: 1) Add additional staff to CHE to manage the volume of proposals and reviews. 2) To ensure that panels have sufficient diversity and expertise, supplemental ad hoc reviews with panel review should be utilized where appropriate. 3) Utilize hybrid ad hoc/panels, cybermeetings/panels, and panels out of DC to broaden participation. 4) Need a more robust database for assigning and tracking reviews, and include an opt-in/out for reviewing similar to journals. 5) Require within the NSF biosketch a history of grant reviewing.

4. How well has CHE built bridges to other divisions, directorates, federal and international agencies embracing cutting-edge science including interdisciplinary topics?

CHE now shares one program officer between CHE and DMR and another program officer between CHE and MCB. This is viewed as an excellent move to facilitate funding the best work at these interfaces. Collaboration between CHE and other federal agencies was less evident during the COV review, although the workshops on gender equity, minorities and persons with disabilities were co-funded by CHE along with NIH and DOE. CHE staff may benefit by increased interactions with NIH and DOE program officers by sharing strategies for proposal review. For example, NIH has undergone substantial changes in both proposal preparation and review over the past few years, and has experimented with cyber review. Lessons learned in one agency could facilitate evolution of procedures at NSF.

The international component of the CHE portfolio has also increased substantially in the past 3 years, and the Division Director's efforts in this area are highly commendable. The COV expressed some concern over the fact that the growth in the international REU programs may be coming at the expense of domestic REU programs. Because domestic REU programs are the lifeblood of research efforts in a number of PUIs and are also recruiting tools for RI universities in the US, some care should be taken in finding the balance between domestic and international programs.

Among individual investigators awards, there has also been substantial growth in programs with new collaborations added in Japan, Russia, France, Luxembourg and Spain in addition to earlier awards co-funded with Germany, China, and elsewhere. Importantly, these programs compete in the regular award areas rather than being competitions for funds set aside. This helps insure that only the best, most compelling chemistry collaborations are funded. The COV recommends that this policy continue.

An important aspect of the international component of the CHE portfolio is the partnering of investigators that occurs at international workshops (CS^3, for example) especially when global grand challenge issues are being addressed (e.g. energy and sustainability).

5. A. Has CHE responded appropriately to the 2007 COV report? For example, in response to the last report, CHE developed a strategic plan. Are there comments on the strategic plan and how it is working? B. One recent outcome of the strategic planning is a major realignment of the programmatic areas. Does the COV wish to comment on the realignment?

The NSF Chemistry program has been very responsive to the recommendations articulated the 2007 COV report. As urged by the COV, the division engaged in strategic planning to better focus its activities and future directions. This is particularly important at a time when the agency is predicted to experience unprecedented growth in its budget. The COV was particularly interested in issues related to transparency, improving the effectiveness of the review process and in assessment of the two submission windows, new programs, and broader impacts. The strategic plan articulated by NSF identified 8 critical issues for the chemistry division:

1. Advancing American competitiveness
2. Communicating the value of chemistry to the public, articulating the importance of chemical research and improving their interface to the chemistry community
3. Increasing global engagement

4. Increasing grand challenge research through centers
5. Broadening participation in chemistry
6. Addressing funding needs of investigators across career stages
7. Assessing the impact of the broader impacts review criterion
8. Updating the division of chemistry structure

One outcome of this strategic planning process was the reorganization, informed by broad input provided by the chemistry community, of the structure of the NSF Chemistry Division, mapping areas previously organized around the traditional chemistry divisions into thematic areas that may better reflect the applications and interfacial areas and emerging directions of molecular science. This reorganization was seen as an effort by the Chemistry Division to be responsive to the scientific directions set by the broader community rather than a top-down setting of direction. The COV was impressed by the bold directions set through this reorganization, but also recognized the need for formal assessment of the effectiveness of the new structure over the next three-year period.

Other issues addressed from the 2007 COV included the shrinking size of single investigator grants and its impact on transformational research. This issue was also discussed by the 2010 COV and continues to be a challenge for the Division, with the exception of 2009 which included ARRA funding. Indeed the 2009 Chemistry response to this issue included the statement "Despite great effort, CHE has not succeeded in arguments for substantially more funds for the subdisciplinary research programs. However, CHE has been successful in obtaining new funds for large projects such as centers and facilities, providing new resources for the chemistry research". While they have reported small increases in the number of grants to single investigators, an obvious strategic direction that is clear from their response is the decision to increase funding for potentially high impact centers.

SIGNATURE BLOCK:

For the Chemistry Division 2010 COV
Cynthia J. Burrows, Chair