Executive Summary

The EAR Instrumentation and Facilities program is a well-run, essential program for Earth Sciences. Instrumentation enables cutting-edge, transformative, and inter-disciplinary science. And as geoscience research becomes increasingly quantitative, the need for this instrumentation is growing.

The POs have done a tremendous job in the face of increasing proposal pressure and flat budgets to fund crucial instrumentation across a broad swath of organizations, with a broadly representative PI base. Therefore, our main message to NSF is:

Please keep up this work. It is absolutely essential to the well being of Earth Science research in the US and for the US to maintain its competitive edge in science and engineering.

Furthermore, the MRI program could never be a substitute for the IF program, given that only 2-3 proposals are allowed per institution per year and Geoscience must compete with all other sciences for these few allotments.

Main highlights of our review and recommendations:

1) The IF program does a terrific job in addressing **broader impacts**. While every project in this program satisfies the BI criteria, as every project builds infrastructure, all projects nevertheless seek to go beyond this through education and outreach. Moreover, the program is to be commended for instituting an early career scientist program (pre-tenure). Currently, this program constitutes only 6% of the IF budget and yet should have lasting impact on our community. The Program has also introduced a budget supplement, of up to $20K per proposal, to enhance the BI of projects.

2) The elimination of mandatory **cost-shares**, as of 2005, resulted in a marked increase in funding requests to the IF program that resulted in a plunge in proposal success rate (from 50% to ~30%). Furthermore, the recent (January 2012) elimination of all voluntary cost-shares is a serious problem that will lead to further deleterious effects on the IF program. While the admirable intent of this National Science Board policy was to "level the playing field", the unfortunate effect was to level the playing field and lower it onto the floodplain! The lack of institutional cost-shares significantly impairs the ability of IF to fund a broad range of projects, also making it more difficult to support instrumentation at smaller educational institutions -- exactly the opposite effect of the intention of the NSB policy. Leveraging of funds by the IF POs has been important in making scarce resources go further. Such leveraging involves co-funding with other NSF programs, other funding agencies, other governments, and private foundations. Why eliminate an important source of leverage – universities who are willing and able to supply cost-shares? The COV notes that most universities are already accustomed to cost-sharing for instrumentation

because such cost shares are required for MRI Proposals. We recommend that the IF proposal to re-institute cost-shares should be strengthened, revised, and submitted to management for review.

3) **Balance**. There is a continuing demand for multi-user facilities. Those funded by IF have been highly successful and are models of well-run organizations that allow access to cutting-edge instrumentation by a wide cross-section of the community. Facilities that were not run well lost funding, and some well-run facilities have managed to become self-sufficient and operate without direct NSF support – so the process works! Yet these facilities are consuming an increasing share of the IF budget: currently facilities constitute nearly ¾ of the entire budget. It is absolutely crucial that both facilities and individual instruments be funded in order to keep the US competitive with the rest of the world. In the face of a declining budget, this is even greater rationale to re-institute cost-sharing on IF proposals to allow existing funds to go farther.

4) There is a crucial need for infrastructure in the **mid-range budget category**: $4 to $50 M. IF currently helps to fill this gap through funding of facilities. A GEO-wide program for funding mid-range infrastructure would benefit EAR and perhaps remove some pressure from the IF program.

5) Funding of proposals from **minority PIs** may be an issue for further investigation. There was a decrease in the success rate of proposals submitted by PIs from minority populations from 2010 to 2012. Although the numbers are small and one or two proposals could change the result significantly, this is cause for concern. Perhaps these proposals could be reviewed to determine the reasons for the declines and to see if there is any obvious way to counteract this trend.

6) **Return rate of reviews** is historically disappointing. One way to perhaps increase the yield would be to require reviewers to respond to the request – either agree or decline. If they do not do so within a week of receiving the request, a follow-up email could be automatically generated. (Checking responses and re-requesting responses should be automated, as is commonly done by most professional journals.) Once a PI has agreed, they may feel compelled to follow through.

7) For **multi-user facilities** that are routinely strongly reviewed, perhaps consider increasing the funding cycle period (e.g., from 3 years to 5 years). This would help to lessen the workload on POs, PIs, ad hoc reviewers and panelists.

8) The POs endeavor to avoid **COI** when sending proposals for review. When COIs are self-identified by the reviewer, the review is marked as a conflict by the PO and is not considered further. Inevitably, however, given the proposal load, some self-identified reviewer COIs were not caught. We recommend continued and perhaps increased diligence to eliminate reviewer COI. This could be facilitated

by having any review that is returned with text in the COI box to be automatically flagged for PO attention. The POs could then decide whether or not there is a conflict and perhaps provide text to explain their decision regarding the potential COI in the review analysis.

CORE QUESTIONS and REPORT TEMPLATE
for
FY 2013 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2013 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2013. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at www.inside2.nsf.gov/od/oia/cov .

NSF relies on the judgment of external experts 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. Committee of Visitor (COV) reviews provide NSF with external expert judgments in two areas: (1) assessments of the quality and integrity of program operations and program-level technical and (2) managerial matters pertaining to proposal decisions.

The program(s) under review may include several sub-activities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the sub-activities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise Information System (EIS) –Web COV module, which can be accessed by NSF staff only at http://budg-eis-01/eisportal/default.aspx. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

For section IV addressing portfolio balance the program should provide the COV with a statement of the program's portfolio goals and ask specific questions about the program under review. Some suggestions regarding portfolio dimensions are given on the template. These suggestions will not be appropriate for all programs.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in the integrity and efficiency of the ***processes*** related to proposal review. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. ***COV reports should not contain confidential material or specific information about declined proposals.*** The reports generated by COVs are made available to the public.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see http://www.nsf.gov/od/oia/activities/cov/covs.jsp.

FY 2013 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: 29-31 May 2013
Program/Cluster/Section: Instrumentation & Facilities Program
Division: Earth Sciences
Directorate: Geosciences
Number of actions reviewed: 90 **Awards:** 33 **Declinations:** 57 **Other:**
Total number of actions within Program/Cluster/Division during period under review: 633 **Awards:** 186 **Declinations:** 447 **Other:**
Manner in which reviewed actions were selected: A random group of proposals was selected by Program staff and presented to the COV chair for final approval. Additional Facility Support proposals were added for completeness.

COV Membership

	Name	Affiliation
COV Chair or Co-Chairs:	Dr. Roberta Rudnick Dr. G. Randy Keller	University of Maryland University of Oklahoma
COV Members:	Dr. Estella Atekwana Dr. Guy Hovis Dr. Terry Tullis Dr. Yang Wang Dr. Michael Williams	Oklahoma State University Lafayette College Brown University Florida State University University of Massachusetts, Amherst

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(s) under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

I. Questions about the quality and effectiveness of the program's use of merit review process. Please answer the following questions about the effectiveness of the merit review process and provide comments or concerns in the space below the question.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: Based on our observations, the review methods are appropriate and effective. Our committee examined 84 proposal jackets selected to cover the broad diversity of EAR sub-disciplines and proposal type (e.g., Equipment Acquisition -- EA, Facilities -- FS, Instrument and Technique Development – ITD and Early Career -- EC). All proposals that we examined received the minimum number of reviews mandated by NSF (3), and typically, the number of reviews was well above this. Each proposal was also evaluated by a program officer (PO). The average number of ad hoc reviews per proposal was 5.2 during the three years under review. This is similar to the average number of reviews documented by the 2007 and 2010 COVs (5.5 to 5.8, and 4.9 to 5.9, respectively). Panel reviews are provided for only a subset of proposals. Due to shear numbers, the panel cannot review all proposals (the number of proposals reviewed by the panel is capped at 60); those selected for panel review and discussion generally fell within the "gray zone" (i.e., declines with average ad hoc review scores >4.0 and awards with average scores <4.0), or represented major facilities. Site visits of the largest facilities are organized to coincide with panel meetings, which occur twice each year. In addition, some PIs of other facilities visit the panel to provide reports, and the program officers arrange visits to other facilities between panel meetings. While we had little information about the workings of these site visits, COV members who have also been panelists reported that those they experienced were effective.	Yes

Finally, the review analyses of the POs are comprehensive, and their funding recommendations reflect careful consideration of all previous reviews. This can result in awards that do not exactly mimic the numerical averages of ad hoc reviews.	
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: The COV noted that both the proposers and the mail reviewers generally address the intellectual merit and broader impacts of proposed work. It was common, however, for both the mail reviewers and the panel to focus more on intellectual merit than broader impacts. The Program Officer review analyses generally summarized both review criteria as addressed by the PI(s). We note that proposers addressed broader impacts of proposed research in various ways appropriate to each proposal and PI. One proposal might emphasize service to a larger community of scientists, particularly in the case of a facility, whereas another proposal might discuss outreach to younger scientists (high school and middle school students), or activities to foster involvement in science for underrepresented groups. It is important to note that the proposals seen by this COV were written prior to recent agency-wide clarification about what "broader impacts" includes. Even so, there is no doubt that in the overall evaluation of proposals "broader impacts" were considered. Having said this, "intellectual merit" appears to be the primary qualification for funding. It is likely that the recent attempt by NSF to clarify the meaning of "broader impacts" will result in future proposals that address this area clearly and thoroughly. The next COV for this program might pay special attention to see if this has occurred.	Yes, but not in all cases Yes, but not in all cases Yes

3. Do the individual reviewers giving written reviews provide substantive comments to explain their assessment of the proposals? Comments: The COV examined 84 proposal jackets. In general, the reviewers did provide substantive comments to explain their assessment, but there was considerable variation in the extent of the comments. In most cases, reviewers evaluated both the scientific merit and broader impacts of the proposals. For FS and EA proposals, most reviewers also provided comments on the management plans. Many of the high-scoring (>4.0) proposals were not funded due to budgetary constraints.	Yes, but not in all cases. Some are substantive and others are not.
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel summaries were generally rather brief. Much like the reviews, the panel summaries varied considerably in detail. Especially for those proposals having mixed ad hoc reviews, the panel usually did a good job of explaining why it agreed with some of those reviews and not others. As appropriate, the more detailed summaries tended to focus on mid-ranked proposals for which the decisions were not clear at the time of the panel meeting. In some cases, proposals ranked highly by both the ad hoc and panel reviewers were not funded due to financial constraints. Some of these panel summaries were briefer than might be ideal, apparently due to the panel assumption that the proposal was likely to be funded.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? Comments: The information in the jackets includes the full proposal, context statements, individual reviews, panel summaries, site visit reports (where appropriate), program officer comments/review analysis, and staff diary notes from telephone calls or email correspondence. The jacket documentation provided a well-justified rationale for the award/decline decision made regarding proposals. The COV found that the information was generally complete. We found that there were several proposals with excellent overall mail review scores that were declined. We found that the Program Officers did an excellent job with the review analysis and provided detailed justifications for why the proposal was not funded. In these positively reviewed but declined proposals, the COV was very satisfied with the review analysis.	Yes

6. Does the documentation to the PI provide the rationale for the award/decline decision? Comments: The communication to the PI takes several forms. Award letters are the most detailed form of communication. However, other communications include encouragement for the PI to revise and resubmit or indications that funding might be available. The notice that the proposal would not be funded was generally the briefest document. By contrast, the award analysis by the PO, which is not sent to the PI, is very informative and substantive. In cases where no panel summary is available for well-reviewed proposals, it would be helpful if the PO provided as much explanation as possible to the PI. ***Recommendation: Make the review analysis by the PO (redacted as necessary) available to PIs. We recognize that this adds additional work for the POs, but perhaps the PO could include similar details in the PO comments while removing sensitive information.***	Yes
7. Additional comments on the quality and effectiveness of the program's use of merit review process: ***Recommendation: For multi-user facilities that are routinely strongly reviewed, perhaps consider increasing the funding cycle period (e.g., from 3 years to 5 years). This would help to lessen the workload on POs, PIs, ad hoc reviewers and panelists.***	

II. Questions concerning the selection of reviewers. Please answer the following questions about the selection of reviewers and provide comments or concerns in the space below the question.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: The Program Officers showed good judgment in selecting reviewers. However, it is clear that attracting a sufficient number of qualified reviewers is difficult. We were surprised at the high number of reviewers contacted and the low response rate. It is hard to recommend a solution to this situation, although **we offer a possible solution below under comments**. The POs provided information about the extensive reviewer database and appear to be making good use of it. The POs appear to be very familiar with the population of scientists who are appropriate to use as reviewers for the variety of proposals they receive. The percentage of female reviewers seemed low to us, although the statistical data are incomplete.	Yes
2. Did the program recognize and resolve conflicts of interest when appropriate? Comments: The POs endeavor to avoid COI when sending proposals for review and also endeavor to honor requests of PIs regarding reviewers to avoid. When COIs are self-identified by the reviewer, the review is marked by the PO as a conflict and is not considered further. Inevitably, however, given the proposal load, some proposals are inadvertently sent to reviewers that the PIs have requested to avoid, and, at least in one instance, a self identified reviewer COI was not caught by the POs. One instance out of ~400 reviews considered here is not an overly worrisome statistic, though there may be ways to improve the flagging of such conflicts (see recommendation). ***Recommendation: We recommend continued and perhaps increased diligence to eliminate reviewer COIs. This could be facilitated by having any review that is returned with text in the COI box automatically flagged for PO attention. The POs could then decide whether or not there is a conflict and perhaps provide text in their review analysis to explain their decision.***	Yes
Additional comments on reviewer selection: The COV is satisfied that the POs of the IF program seek a balanced,	

reasonably diverse, and knowledgeable slate of reviewers. Nonetheless, providing historical records of past review scores for reviewers in the database could be perceived as leading to bias in reviewer selection (we emphasize here that we do not believe this to be the case for this program). We therefore do not see the benefit in having the historical review information in the database. It opens the program to the possible charge that a PO could bias the ad hoc reviews by preferentially selecting reviewers with either historically high or low scores.

Recommendation: Remove information about past reviewer rankings from the reviewer database.

The COV appreciates the Program Officer's approach to seeking breadth in panel expertise, so that the problem of having only one expert in a given field is avoided. However, attention should be paid to increasing the number of female reviewers and panel members. The data provided to us about reviewer demographics suggests that the proportion of ad hoc reviews from women is below their proportion in the community (~8% of IF reviewers are women*, cf. ~20% female AGU members, Holmes et al., 2011, *EOS*, and 14% female tenure-track faculty members in US institutions, Holmes et al., 2008, *Nat. Geoscience*; AGI Database). The proportion of women serving on the panels in the three years under review was higher, varying from 12 to 38%, with most panels having around 20% women. Nonetheless, given that women are either PI or Co-I on 36-44% of the proposals submitted to this program, and on ~30% of the funded proposals (see graphic in section IV 9), increasing the representation of women on the IF and associated MRI panels is recommended.

Recommendation: Strive to seek reviews from a broadly representative reviewer base. In particular, increase the proportion of female ad hoc reviewers and panel members.

Our committee was disappointed to see how many reviewers do not respond to review requests and ultimately do not complete proposal reviews. In many cases, less than 50% of the review requests were completed. One suggestion for the I/F Program and for all of GEO is to include a response box in the invitations to review proposals. The potential reviewer can click to indicate that they can or cannot complete the review. There are two potential benefits. First, this might give the PO an early indication if a particular proposal has a critically small number of reviewers. Second, by committing to the review, potential reviewers may feel a somewhat greater obligation to complete the review. If there is no response to the request to review, a reminder could be sent, and thereafter, alternative reviewers could be sought.

Recommendation: Include a reviewer response box in the email request and follow up with non-responses through automated emails.

****Recommendation: The data available for gender and ethnicity of IF reviewers are not particularly complete. We recommend that the reviewer database be upgraded to improve this information. Perhaps this could be accomplished through merging of the IF reviewer database with the PI database maintained by EAR.***

III. Questions concerning the management of the program under review. Please comment on the following:

MANAGEMENT OF THE PROGRAM UNDER REVIEW
1. Management of the program. Comments: The COV notes that the EAR IF Program Directors have done an outstanding job in running their program. All indications are that the POs act as fair-minded arbiters of funding decisions based on the mail and panel reviews. It is apparent that care is taken to choose reviewers that have the appropriate expertise for each proposal (see previous section). In several instances where especially large sums of money were requested, Program Officers and Panel members made site visits to the facilities to assure that NSF funds would be put to the best possible use. Clearly, the funding capacity of this program is not adequate relative to the number of worthy proposals; within these confines, the POs have done an excellent job of distributing program funds to the wide range of sub-disciplines served by IF. The IF Program seems to have struck good balance in funding existing facilities, in providing funding to young investigators and also in weaning some existing facilities off NSF funding, while at the same time offering useful advice that helped keep those facilities in operation via other support. In speaking with the POs, it becomes evident that they have significant familiarity with the scientific community they serve. ***Recommendation: We see a continuing need for three officers in this program, given the very significant number of proposals received by EAR IF, the need to provide substantive feedback to individual PIs, as well as other duties required of the POs, such as site visits to facilities.***
2. Responsiveness of the program to emerging research and education opportunities. Comments: The POs appeared very attuned to emerging research and education opportunities. They have worked with IRIS and UNAVCO to react to research opportunities, and through the very robust educational programs of these facilities, the program is keeping abreast of emerging educational programs. The same can be said of most of the other Multi-user Facilities. One category of proposal funded by the program is building and developing new instruments that are viewed as creating emerging research opportunities. The COV concludes that this program has been very responsive to emerging research and education opportunities by funding facilities and equipment request that catalyze collaborations and interdisciplinary research in emerging research areas. We provide the following example: EAR 0949336 for the development of a high-resolution gas source isotope ratio mass spectrometer (in partnership with the engineering team at Thermo Fisher Scientific ('Thermo')) as a good example of a funded project that demonstrates the responsiveness of the program to emerging research and education opportunities. The project is to build a new high precision and high mass resolution mass spectrometer for advancing the new and emerging discipline of clumped isotope geochemistry – "the study of naturally occurring multiply substituted isotopologues". This new field has the potential to provide deeper insights into conditions on Earth in the past, the controls on climate change, the

sources and sinks of greenhouse gases (such as methane and CO_2) in the atmosphere, and the mechanisms of chemical reactions that are important in geochemistry. Nonetheless, the COV noted the lower number of ITD submissions and therefore funding (~6% of total IF budget).

The COV also noted that the program does an excellent job in co-funding interdisciplinary and cross-disciplinary proposals within the Geosciences Directorate. However, this was more challenging to do across directorates. Since most transformative research occurs at the interface between disciplines (often involving different directorates), the COV encourages the POs to seek solutions to some of the barriers that inhibit co-funding across directorates.

Recommendation: The COV recommends that the POs work with the community to solicit more innovative ITD type proposals, as these proposals, if successful, can catalyze new research directions. The COV also recommends that the term "analytical" be taken out of the current solicitation, as this might present a barrier to the type of proposals submitted (see also Section IV 3).

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

Comments: The EAR IF "Guiding Principles" document clearly states the principles and criteria that the IF POs use to guide their investment decisions. For example, priority is given to "new starts" that develop partnerships within NSF, with other Federal agencies and internationally, as well as "new starts" that are programmatically important, such as new research areas, early-career PIs and PIs from underrepresented groups. Priority is also given to "maintenance/upgrade" requests that are well justified for laboratories where EAR/IF originally funded the equipment, as well as well-justified proposals that the program was unable to fund previously (given equal mail and panel review recommendations). Multi-user facilities represent the largest investment of the IF program (74%) and benefit large user communities. During tight budgetary times, the facility funding must be held at "maintenance" levels to protect the significant investment in these resources and to avoid irreversible losses to capabilities. From the proposal jackets that we examined, it is abundantly clear that the POs have worked diligently to follow these principles and the NSF merit review criteria in the development of its very diverse portfolio.

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

Comments: The IF program has responded positively and proactively to comments and recommendations from the 2010 COV. Many of their recommendations have been implemented, including:

1) Continuing to apply the BI criterion with some flexibility between weighting of the two criteria. In addition, in 2011 two new BI-related opportunities were introduced: a) an early career opportunity that encourages early career (pre-tenure) scientists to submit equipment acquisition proposals, as well as request support for technical staff, and b) the opportunity to request up to $20K to facilitate BI.
2) Regarding the vexing issue of cost-sharing, the POs produced a draft document with a cost-sharing plan for the program, but the plan is on hold pending review by the new division staff. In the meantime, cost-shares, which were formally permitted but not required, have become prohibited at NSF in all programs save the MRI program (see final section of this report for a recommendation regarding cost-shares).
3) A third PO position in the program has been made permanent. This position is now ably filled

by Jonathan Wynn.

4) PO communication to PIs has improved, mainly due to the presence of a third PO, which has allowed more substantive comments to be transmitted to the PIs of proposals that were declined (though see recommendation in Section 1, Item 6).
5) The POs are cognizant of the need to strike a balance within the program so that the scientific diversity of EAR is well represented in IF projects. In response, two new facilities have been funded that serve the hydrologic and Earth surface sciences communities (CTEMPS and OpenTopography).
6) The POs continue to seek leverage from other sources to support IF projects. In particular, a new facility, COCONet, has been co-funded with a large diversity of other institutions and agencies.

A few other recommendations (e.g., requesting PIs to submit their "top 10" papers, holding workshop for project managers) were not implemented for a variety of reasons, including changing reporting practices at NSF, increasing travel restrictions, etc. Finally, some other recommendations made by the COV pertain to policy that is set at higher management levels than the IF program (e.g., extending MRI to $10 or $20M cap), and are not within the purview of the IF program to implement. Nevertheless, it is important for NSF management to address these critical issues (see Other Topics section).

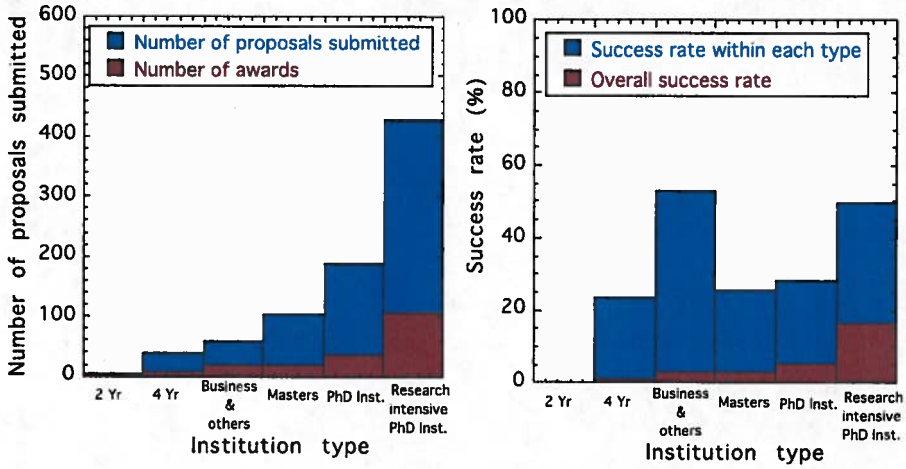
IV. Questions about Portfolio. Please answer the following about the portfolio of awards made by the program under review.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
1. Does the program portfolio have an appropriate balance of awards across disciplines and sub-disciplines of the activity? Comments: The balance seems appropriate. While most of the equipment acquisition and upgrade awards are made for analytical and microbeam equipment, geophysical equipment is funded mainly through IRIS and UNAVCO, which serve a significant proportion of EAR geophysics investigators with major equipment needs. The portfolio of funded instruments and Multiuser Facilities is very broad, and steps taken by the POs (e.g., only funding a single microprobe at a time) indicate a strong commitment to balance in funding. The funding rate and average award size appear correlated with proposal requests, which is another indication of balance. The active efforts at leveraging IF funds is also a means of maintaining balance.	Appropriate
2. Are awards appropriate in size and duration for the scope of the projects? Comments: We have carefully considered the size and duration of awards, and of requests, during the period 2010-2012. All of the data indicate that the size and duration are entirely appropriate for the scope of the proposed projects. Awards for single instruments were generally made based on the quoted price of the particular instrument. Based on prior knowledge of the PI or of the IF Program, awards have been made at a somewhat reduced amount than the quoted price on the assumption that instrument prices can be negotiated downward. We are not aware of any situation where the award was insufficient to purchase the requested instrumentation. In addition, the supplement process has been well used when unexpected changes caused the instrument price to increase. Several awards were reduced because the panel, outside reviewers, or POs determined that part of the requested equipment was unnecessary or unwarranted. These decisions were carefully explained in the proposal jacket. Facility proposals also appear to be appropriate in size for the scope of the projects. The duration is generally fixed in advance – generally three years, but up to five years for very large facilities (e.g., IRIS and UNAVCO). In order to reduce workload, the POs might consider extending the award period from three years to five years for a subset of smaller facilities that routinely review strongly. The Committee noted that the total number of awards dropped significantly	Appropriate

during the three-year period of this review from 76 in 2010 to 57 in 2011 to 43 in 2012. The average award size increased (from $179, to $199, to $212), but not in an amount that would compensate for the diminished number of awards. To some extent, the drop in numbers of awards can be explained by the increase in awards due to stimulus funds in 2010 and by the IF equipment acquisition proposal "holiday" taken in 2012. However, considering the increasing demand for instrumentation for all aspects of EAR research, any reduction in the number of awards is of significant concern. ***Recommendation: The POs might consider extending the award duration for smaller facilities that routinely review strongly from three years to five years. Such a change could be by invitation only at the discretion of the POs.***	
3. Does the program portfolio include awards for projects that are innovative or potentially transformative? Comments: There are many excellent examples of innovative and transformational research in the IF program. All the largest facilities and most, perhaps all, of the facilities supported by IF were innovative when they originally began and continue to be transformational. They have totally changed the way science is done in many disciplines within EAR. In particular, and importantly, they have made the playing field more level for investigators from all types of institutions because they provide equal access for everyone to data and to state-of-the art experimental and analytical facilities. Two types of instrumentation are supported by IF: acquisition and development. Although the use of some instruments acquired through instrumentation acquisition proposals might lead to innovative or transformational research, the acquisition itself is neither. On the other hand, development of new instruments, or of new techniques, is nearly always innovative and, if successful, will in all likelihood be transformational. Several examples of such instrument development projects were included in the projects we reviewed. ***Recommendation: The IF program should give some preference to instrument development proposals relative to instrument acquisition proposals because of the greater potential for leading to transformational science.***	Appropriate
4. Does the program portfolio include inter- and multi-disciplinary projects? Comments: The geosciences, by their very nature, are interdisciplinary. Various proposals represent different combinations of applied physics, chemistry, biology, math, computer science, and engineering. Biogeoscience has become a prominent part of the geosciences in recent years, and this is reflected in a number of the requests. Collaborative relationships among physicists, geoscientists, spectroscopists, and engineers are evident in	Appropriate

cooperative high-pressure research. Pioneering work in isotope detection and application offer opportunities for new scientific discovering among important disciplines ranging from plate tectonics to soil science. Mineralogy, mantle petrology, and materials science have interesting new partnerships. In addition to traditional connections among the various sub-disciplines in the Earth sciences, therefore, one sees proposals funded by EAR IF that help make new connections. The EAR IF Program has done an excellent job of supporting crossover science, reflecting in part the fundamental interdisciplinary nature of the EAR enterprise. See also comments in section III 2 about improving cross-directorate funding capabilities.	
5. Does the program portfolio have an appropriate geographical distribution of Principal Investigators? Comments: The Principal Investigators cover a wide geographic distribution, with the number of awards generally reflecting the number of proposals submitted, which also reflects population. Nonetheless, some states had higher submission numbers, and the total number of awards reflected this (e.g., California, Texas, New York), whereas other states had few submissions. For example, only one submission was made from each of Nebraska, Oklahoma, Rhode Island and South Dakota. In addition, some states received no funding from the program over the three-year review period: AR, DE, ME, MS, NE, NV, NH, ND, OK, RI and WV. All of these are EPSCoRE states. Nevertheless, the funding rate for proposals from EPSCoRE states is similar to the overall funding rate (23-31% vs. 26-35%, respectively, over the three year review period). Proposals and Awards by State 	Appropriate, though 20% of states (all EPSCoRE) received no funding from the IF program during the review period.
6. Does the program portfolio have an appropriate balance of awards to different types of institutions?	Appropriate

Comments: Proposals submitted to the IF program during the review period (2010-2012) come from all types of institutions. However, the absolute number of proposals submitted varied considerably among institutions (see figure below). As might be expected, research-intensive PhD institutions submitted the largest number of proposals; they also received the largest proportion of total funds (64.9%). Proposals submitted from business/state/local/others received 19.3% of total funds, and the remaining balance was awarded to graduate-serving institutions (14%) and 4-year non-graduate-serving institutions (1.8%). Of the funded proposals (29.4% of total proposals submitted, on average), the highest proportion (16%) went to research-intensive PhD institutions due to the large number of proposals submitted from these institutions ("overall success rate" on the right panel, below). However, the success rate within each institution type is more or less comparable (with the exception of 2 year institutions), ranging from ~22-23% for 4 year and graduate serving institutions to ~33% for research-intensive PhD institutions and 50% for business/state/local/others (see figure below). This analysis suggests that the portfolio is well balanced and reflects requests from the community.



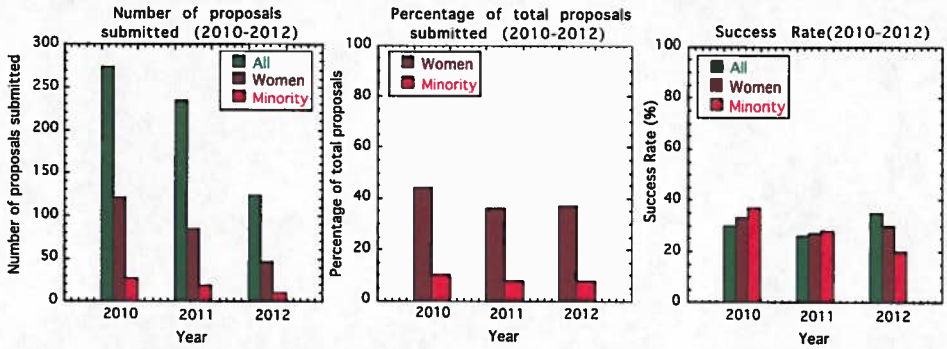
7. Does the program portfolio have an appropriate balance of awards to new investigators?

This is a tricky question with respect to the IF program. Many reviewers of IF proposals consider that funding of science projects should precede funding of instrumentation. Given this bias (whether legitimate or not), proposals from many new investigators do not make the funding cut-off. This is reflected in the average success rate for new investigators (~19%) that is below the average for all investigators (~30%). On the other hand, the IF program has instituted an early career award category that seeks to provide instrumentation, as well as technician support to early career (pre-tenure) faculty. The success rate for such early career PIs is 33-43%, on par or exceeding the total success rate. Nevertheless, the proportion of the total budget for this award category is still quite low (6%) and perhaps could increase, if proposal pressure is there.

Appropriate

Recommendation: We recommend continuing to support early career scientists and perhaps increasing the proportion of the IF budget that goes to such PIs, provided sufficient numbers of high quality proposals are submitted.	
8. Does the program portfolio include projects that integrate research and education? Comments: In most of the multi-user facilities, research and education are integrated. A number also support educational activities for K-12 students and for the general public. Many small colleges have successfully competed for funding and their efforts, almost by definition, integrate research and education. For example, in the proposals available for the COV to review, PIs from Montclair State University, College of Charleston, Colgate University, Coastal Carolina University, Drew University, Lafayette College, Luther College, Middlebury College, Smith College, Union College, the University of Maryland Baltimore County, and Washington College, to name a few, all received funding.	Appropriate
9. Does the program portfolio have appropriate participation of underrepresented groups[1]? Comments: The proposal success rate for the IF Program has remained relatively stable at approximately 30% (30%, 26%, 35%) during the three-year period from 2010 to 2012. The success rate for proposals involving women (see Figure below) is also relatively stable and also comparable to the overall pool of proposals, approximately 30% (33%, 27%, 30%). By contrast, the total number of proposals from minority PIs has diminished slightly over the three-year period (10%, 8%, 8%), and the success rate has diminished from 37%, to 28%, to 20% (see Figure). Although the numbers are rather small and so uncertainties are large, this decline is a matter of significant concern, as it suggests that the involvement and the proposal success of minority PIs has diminished.	Appropriate

[1] NSF does not have the legal authority to require principal investigators or reviewers to provide demographic data. Since provision of such data is voluntary, the demographic data available are incomplete. This may make it difficult to answer this question for small programs. However, experience suggests that even with the limited data available, COVs are able to provide a meaningful response to this question for most programs.



Recommendation: We suggest that effort be made to evaluate the significance and possible causes of the decline in proposal numbers and success rates of minority PIs and, especially, that steps be taken to reverse the trends. For example, review all of the past proposals from identified minority PIs and evaluate the review and analysis process. Where did these proposals fall within the overall spectrum of proposals?

10. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The IF Program addresses all of these needs, as described here. National Priorities: Although these also fall under the missions described in the NSF Agency Mission discussed below, three priorities worth highlighting are issues concerned with energy, climate change, and jobs. For energy, a variety of basic research topics concerning fossil fuels and geothermal energy fall under the purview of EAR. IRIS, in particular, provides important infrastructure related to energy, notably the recent need to better understand induced seismicity related to disposal of fluid wastes from industrial shale gas recovery efforts. A RAPID proposal funded through IF responded to the Deepwater Horizon oil spill in the Gulf Coast. Much climate change research is done in other parts of GEO, but EAR also undertakes relevant research that is supported by the IF program. These include its support of continental drilling, understanding of increased ice-sheet related seismicity via the GSN that is supported by IRIS, as well as IRIS support of seismic studies carried out by the Office of Polar Programs. In addition to jobs directly provided by the research supported by IF and EAR, jobs are also produced by commercialization of new instruments that are created through the IF program to support the development of new instrumentation, examples of which are likely to occur from grants funded in the 2010-2012 time frame. Agency Mission: The NSF Act set forth a mission: *"to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes."* IF is clearly advancing the *progress of science* within EAR, which is the primary focus of IF support. The science being done within EAR is increasingly dependent on instruments, so the IF program is even more important than in the past. Advances in *national health, prosperity, and*	Appropriate

welfare result from a variety of IF programs, as discussed under National Priorities. IF support of the GSN through IRIS provides critical support of our nation's efforts to *secure the national defense*. Seismic detection of underground nuclear tests in monitoring the test-ban treaty relies on this support. An example of IF contributions to *other needs* is its support of the COCONet facility. COCONet is a large seismic network in the Caribbean. It responds to pressure on NSF to take action relevant to recent earthquakes, such as that which occurred at Port au Prince in 2010. It is also a great outreach and education opportunity in that it involves scientists and students in all Caribbean countries.

Relevant Fields: For this program the scientific disciplines within EAR represent the Relevant Fields. Within its financial constraints, IF does an excellent job of providing the infrastructure needed for scientists within EAR to make scientific progress, via IF's provision of both instruments and facilities.

Other Constituent Needs: As one example, the IF program has introduced a new program to support Early Career scientists, making it easier for them to obtain support for technical personnel, an innovation that is very welcome.

A relevant external report to this is

Lay, T., et al. (2012), *New Research Opportunities in the Earth Sciences*, The National Academies Press, Washington, D.C.

Several example quotes from this document relevant to IF follow. Many other examples can be found in the same document.

1. *"**Instrumentation and Facilities to Support Research Opportunities**: Although each research opportunity has specific data collection, instrumentation, and facilities associated with it, there are some cross-cutting intersections of needs. For example, understanding Earth system processes requires global networks to collect data, such as long-term observatories and portable instrument facilities for hydrology, rock and fossil sampling and drilling.... A strong theme throughout all the research topics ... is the need to enhance geochronology ... in order to produce more accurate estimates of the age, duration, and rate of events and processes in earth's past. As a result of improvements in analytical methods and in the theoretical underpinnings and calibrations of a range of dating methods, the past few years have seen transformative advances in many approaches to geochronology. Areas of notable growth include more accurate dating of structures on Earth's surface using the rare isotopes produced by cosmic rays, determining the cooling histories of rocks, and the high precision dating of volcanic ash.*
***Recommendation**: The Division of Earth Studies should explore new mechanisms for geochronology laboratories that will service the geochronology requirements for a broad suite of research opportunities while sustaining technical advances in methodologies. The approaches may involve coordination of multiple facilities, and investment in service facilities may differ for distinct geochronology systems."*

We note that the IF program currently supports several facilities engaged in

geochronology and has a good track record in this regard. 2. "*Instrument and Facilities Needs for Faulting and Deformation Research Finding 1: EAR is currently supporting numerous disciplinary facilities that are gathering essential data for understanding faulting processes and associated deformations. Facilities such as UNAVCO, IRIS, the National Center for Airborne Laser Mapping (NCALM), SCEC, CIG, and high-speed computing are important to advancing understanding of faulting processes.*" [*Lay et al.*, 2012b], pg. 76. The IF-program supports UNAVCO, IRIS and NCALM. 3. *"For [studies of] Coupled Hydrogeomorphic-Ecosystem Response to Natural and Anthropogenic Change . . .* *This will require integrated monitoring of landscape processes and development of new instrumentation and data archives to support and test models . . ."* The IF-supported facility National Center for Airborne Laser Mapping (NCALM) is an example of such instrumentation.	
11. Additional comments on the quality of the projects or the balance of the portfolio: Given the large number of proposals relative to the resources of the program, the average quality of funded proposals is outstanding. It is clear that a significantly larger budget is needed to fund an adequate percentage of the highly worthy proposals. The COV wonders whether US science can continue its leadership as funding continues to serve a smaller and smaller percentage of the US scientific community. This will not serve as encouragement to young investigators entering science. The EAR IF program officers have done an excellent job of spreading program funds among various sub-disciplines in the earth sciences, and at the same time keeping existing well-functioning programs running, giving support to new young investigators, and assuring support to a diverse group of scientists. The future, however, is not bright. This program will not be able to continue to serve all these needs as the use of its limited funds become increasingly under pressure. This could, to some degree, be addressed if the program were able to leverage a portion of its funds through cost-sharing with institutions (see item 3A under "other topics", below). Outside of obtaining special dispensation regarding cost-sharing, there is nothing the EAR IF program can do about limited science funding, which must be addressed through increased support for science at the national level. Within the confines of current funding, the COV encourages the program officers to continue the excellent work they have been doing.	

OTHER TOPICS

1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

   None needed.

2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

   Nothing that is not covered above

3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

A. The elimination of mandatory cost-shares, as of 2005, resulted in a marked increase in funding requests to the IF program that resulted in a plunge in proposal success rate (from 50% to ~30%). Furthermore, the recent (January 2012) elimination of any cost-sharing is a serious problem that will lead to further deleterious effects on the IF program. While the admirable intent of this National Science Board policy was to "level the playing field", the unfortunate effect was to level the playing field into the floodplain! The lack of institutional cost-shares significantly impairs the ability of IF to fund a broad range of projects, also making it more difficult to support instrumentation at smaller educational institutions -- exactly the opposite effect of the intention of the NSB policy. Leveraging of funds by the IF POs has been important in making scarce resources go further. Such leveraging involves co-funding with other NSF programs, other funding agencies, other governments, and private foundations. Why eliminate an important source of leverage – universities who are willing and able to supply cost-shares?

Recommendation: The IF proposal to re-institute cost-shares should be strengthened, revised, and submitted to management for review.

B. There is a crucial need for instrumentation in the mid-range budget category: $4 to $50 M. IF currently helps to fill this gap through funding of facilities. A GEO-wide program for funding mid-range infrastructure would benefit EAR and perhaps remove some pressure from the IF program.

Recommendation: GEO should create a mid-range facilities program along the lines of the current MRI.

C. A decline in the success rate of proposals from minority PIs was observed for the review period. While this may reflect the statistics of small numbers, it leads to the question of how minority PI proposals fare overall at NSF.

Recommendation: NSF may wish to reach out to minority PIs in an attempt to determine if there are mentoring steps that might be utilized, especially concerning proposal preparation. A study to determine how minority proposals fared across NSF would also be useful.

4. Please provide comments on any other issues the COV feels are relevant.

Funding of instrumentation is increasingly important in keeping US Earth scientists at the forefront of discovery. Without sustained and even increased funding, US science leadership will diminish and will lag behind that of other countries. For the IF program, re-institution of cost-shares (see #3, above), as well as institution of a GEO-wide mid-range infrastructure program (see #3 above) could help to keep US Earth Scientists with the tools they need to push the boundaries of discovery.

5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The COV only found a few minor issues to address:

The NSF IT group ought to develop a system that automatically identifies Conflicts of Interest of COV members. We noted that some obvious issues such as COV members being reviewers of proposals selected for examination were not caught, even though COV members supplied detailed COV lists beforehand. In addition, COIs between COV members and co PIs of proposal were generally not caught in advance.

Ad hoc review scores mentioned in panel summaries, the review analysis, and any correspondence to the PIs need to be double checked before they are transmitted. We noticed a small number of erroneous scores in our review of the proposals, including the average scores provided on the spreadsheet that was used to select proposal jackets for examination.

Information on gender and ethnicity of reviewers needs to be more readily available.

SIGNATURE BLOCK:

For the Instrumentation and Facilities Committee of Visitors
Roberta L. Rudnick
Chair