

**APPROVED MINUTES  
PLENARY OPEN SESSION  
455<sup>TH</sup> MEETING  
NATIONAL SCIENCE BOARD**

National Science Foundation (NSF)  
Alexandria, Virginia  
February 21-22, 2018

**Members Present:**

Maria T. Zuber, *NSB Chair*  
Diane L. Souvaine, *NSB Vice Chair*  
John L. Anderson  
Deborah L. Ball  
Roger N. Beachy  
Arthur Bienenstock  
Vinton G. Cerf  
Vicki Chandler\*  
Ruth A. David  
W. Kent Fuchs  
Inez Fung  
Robert Groves\*\*  
James Jackson  
G. Peter Lepage  
W. Carl Lineberger  
Stephen L. Mayo  
Victor R. McCrary  
Emilio F. Moran  
Ellen Ochoa  
Sethuraman Panchanathan  
G.P. Bud Peterson\*\*\*  
Julia M. Phillips  
Geraldine L. Richmond  
Anneila I. Sargent

France A. Córdova, *ex officio*

**Members Absent:**

\*Dr. Chandler attended via teleconference on February 21 and was absent on February 22.  
\*\*Dr. Groves absent on February 22  
\*\*\*Dr. Peterson was absent on February 21.

There being a quorum, the National Science Board (NSB, Board) convened in open session at 8:15 a.m. on Wednesday, February 21, 2018, with Dr. Zuber presiding.

## NSB Chair's Opening Remarks

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Dr. Zuber welcomed everyone to the NSB's 455<sup>th</sup> meeting.

Dr. Zuber began the meeting by thanking NSF Director Córdoba and her staff for the expertise with which they have managed the budget uncertainties over the preceding weeks and months. She pointed out that the outreach to the Board to keep its members informed of developments was greatly appreciated.

After a preview of the upcoming meeting agenda, the Chair turned the meeting over to the Director for her opening remarks.

## NSF Director's Remarks

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Dr. Córdoba began with a thank you to the Board for its support of the Foundation and the engagement many Board members have had with Members of Congress and other stakeholders in support of the NSF mission.

Dr. Córdoba then reported that NSF had raised its rankings in the Best Places to Work in the Federal Government, landing at number nine in the most recent survey results, up from tenth position in 2016. The ranking was out of 25 similarly-categorized midsize Federal agencies.

In detailing her own engagement with Members of Congress, Dr. Córdoba highlighted her testimony at a Senate Committee on Commerce, Science, and Transportation hearing entitled "One Year Later: The American Innovation and Competitiveness Act." She stated that she joined Dr. Walter Copan, Undersecretary of Commerce for Standards and Technology, Department of Commerce and Director, National Institute of Standards and Technology, in testifying on the topic of the implementation of science and technology policy and program updates enacted under the AICA, specifically addressing progress made by NSF and the National Institute of Standards and Technology to implement the act.

Dr. Córdoba also visited Representative John Culberson (R-TX), Chairman of the House Appropriations Subcommittee on Commerce, Justice, and Science, to discuss the exciting science coming from the Laser Interferometer Gravitational-Wave Observatory (LIGO). She stated that she was joined by members of the LIGO team and scientists representing the community of observers of the neutron star merger last August. Dr. Córdoba noted that Chairman Culberson was keenly interested in the LIGO achievements as well as the broader NSF investment portfolio, asking many detailed questions over the 2-plus hour conversation.

Dr. Córdoba also previewed an appearance in early March by Dr. James Kurose, Assistant Director for the Directorate for Computer & Information Science and Engineering (CISE), testifying before the Information Technology Subcommittee of the House Committee on Oversight and Government Reform. Dr. Kurose's testimony will be on the subject of Artificial Intelligence.

Next, Dr. Córdova reported on her representational travels abroad. In December, she attended the Noble Prize ceremonies in Sweden. She showed a photograph taken of her with the American winners, all of whom had received NSF support at some point in their careers. She added that the three Nobelists for Physics, Drs. Barry Barish, Kip Thorne, and Rainer Weiss, visited NSF in February for a discussion with NSF staff on the LIGO detectors and the observation of gravitational waves.

Dr. Córdova also reported on her trip to Belgium in January to attend the meeting of the Astroparticle Physics European Consortium (APPEC). APPEC is a consortium of 17 funding agencies, national institutions, and institutes from 14 European countries, responsible for coordinating and funding national research efforts in astroparticle physics. She stated that APPEC officially announced the launch of a new European Astroparticle Physics Strategy 2017-2026, which includes foci on large-scale multi-messenger infrastructures, connecting the infinitely large and infinitely small, mysterious neutrinos, and the dark universe. She noted that many of these topics have been briefed to the Board by the Directorate for Mathematics and Physical Sciences (MPS) in the recent past.

Dr. Córdova continued by highlighting two science achievements by NSF funded researchers. Dr. Douglas Altshuler and colleagues studied the evolution of hummingbird agility with support from the Directorate for Biological Sciences' (BIO) Division of Integrative Organismal Systems. The framework posed in the study may apply to other organisms and to the design of more maneuverable aircraft. Dr. Alan Hastings and colleagues showed that a well-known model from statistical physics and magnetism, the Ising model named after the physicist Ernst Ising, could be used to understand why synchronous biological events occur at the same time over long distances. Their research was co-funded by BIO's Division of Environmental Biology and MPS's Division of Materials Research. Dr. Córdova noted that these were just two examples of a much larger set presented in the newest edition of the *Transforming the World Through Science*, aka the Green Book, published by the Office of Legislative and Public Affairs (OLPA).

Dr. Córdova went on to speak about her attendance at the AAAS annual meeting in Austin, Texas. She congratulated Board member Dr. Artie Bienenstock on his receiving the 2018 Philip Abelson Prize. The award is given by AAAS to individuals who have "made signal contributions to the advancement of science in the United States." Dr. Bienenstock was recognized for his academic leadership, his efforts to improve public understanding of science and his promotion of diversity and inclusion in STEM fields. Dr. Córdova also congratulated Board member Dr. Ellen Ochoa for her plenary lecture on the International Space Station and its value as a research platform.

Dr. Córdova reported that she also participated in two events at the meeting. First, she joined Dr. Jeremy Berg, editor-in-chief of Science, and Sir Mark Walport, the UK's Chief Scientific Adviser, on a panel entitled *Building Public Trust and Fostering Innovation with Transparency*. She stated that the group discussed how the global research system can operate more effectively and further strengthen its integrity. Second, she stated that she participated in a roundtable sponsored by several Canadian universities on the future of quantum research.

Concluding her remarks about the AAAS meeting, Dr. Córdova praised Dr. Meg Urry, the Israel Munson Professor of Physics and Astronomy and Director of the Yale Center for Astronomy and Astrophysics, for a talk she gave on *Sexual Harassment: What It Means and What We Can Do About It*.

Dr. Córdova used her comments about Dr. Urry to transition to her recent comments on the topic of sexual and other forms of harassment. She referred specifically to her February 8, 2018 statement, delivered internally and externally, that the National Science Foundation does not tolerate sexual harassment, or any kind of harassment, within the agency, at grantee organizations, field sites, or anywhere NSF-funded science and education are conducted. She noted that her statement was picked up by the scientific press, the higher education press and the general press. She added that Ms. Rhonda Davis, head of NSF's Office of Diversity and Inclusion, would be addressing the Subcommittee on Research and Technology of the House Committee on Science, Space, and Technology on the topic of sexual harassment during the week of February 26.

Finally, Dr. Córdova announced that two NSF leaders had been awarded Presidential Rank Awards. Dr. Joan Ferrini-Mundy, NSF Chief Operating Officer, received the Distinguished Presidential Rank Award for 2016 and Mr. Michael Sieverts, Acting Office Head for the Office of Business, Finance and Administration, received the Meritorious Presidential Rank Award for 2017.

The Chair thanked Dr. Córdova for her report.

## Summary of DC Meetings and Louisiana Visit

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Dr. Zuber then summarized her meetings in Washington, DC since the last Board meeting. She reported that she met with Senator Murkowski (R-AK), Chair of the Senate Energy and Natural Resources Committee. When discussing the "New Arctic" Big Idea, Senator Murkowski emphasized the need to incorporate local and indigenous populations in any science and/or data collection activities undertaken as part of this initiative. Following that meeting, Dr. Zuber stated she met with Representative José Serrano (D-NY), the Ranking Member of the Commerce, Justice, and Science Subcommittee of House Appropriations. She reported that the Congressman stressed the importance of Arecibo to the people of Puerto Rico, noting that it is not only a science facility, but it is a "symbol of pride and connection" for Puerto Ricans. Dr. Zuber thanked him for his strong support for NSF and for science, and emphasized that the Board wants an open line of communication with him on this issue and on his other priorities for NSF.

Dr. Zuber also met with Senate and House Appropriations staff. On the Senate side, she noted that the discussion focused on the Operations and Maintenance Report requested by the Senate Appropriations Committee. On the House side, the discussion was centered on the *Science and Engineering Indicators 2018* and the associated NSB Policy Brief on the need for a STEM-capable workforce. The staff was particularly interested in the Board listening sessions noting how important it is to hear from the stakeholders.

With no questions or remarks forthcoming, Dr. Zuber adjourned the Plenary Session at 8:45 a.m. with the reminder that the Plenary Open session would reconvene at 11:15 a.m. the following day for a presentation by authors of a report by the American Academy of Arts and Sciences entitled "The Future of Undergraduate Education."

## Session 2

Dr. Zuber reconvened the Plenary session at 11:15 a.m. on February 22, 2018.

### Chair's Remarks

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Dr. Zuber welcomed everyone back to the Open Plenary session. She thanked Drs. Francesca Purcell and Sandy Baum from the American Academy of Arts and Science for coming to the meeting to present on their report, "The Future of Undergraduate Education." She then turned the floor over to Dr. Deborah Ball, who moderated the session.

### American Academy of Arts and Sciences Presentation

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Dr. Ball began by introducing the report and stating that she was pleased it dealt with the issue of the undergraduate experience in an integrated manner, examining quality of teaching, quality of opportunities, and the support students need to complete their undergraduate degrees holistically. She then gave the floor to Dr. Purcell, who addressed the specifics of the report.

Dr. Purcell noted that the report is the result of a two-year, iterative process that included a number of consultations across the country with students and faculty from various institutions, federal legislators, and leaders and experts from the higher education, business, and technology sectors. She added that the report moves beyond the quest for universal access to higher education, because today roughly 90% of high school graduates have some experience with college, university, or post-secondary education in their young adulthood. She said the pressure now is to focus on what students are actually learning, what's happening during the college experience, what's happening in terms of completion rates, and how the system is dealing with issues of affordability.

Dr. Purcell went on to discuss the issues of teaching quality, leaving the affordability discussion to be handled by Dr. Baum. The fundamental problem, according to Dr. Purcell, is that the wealth of research on how students learn and what methods are most effective in the classroom is not applied in the educational experience. Quoting from the report, she stated, "Quite simply, students learn more and fail less when faculty members consult and utilize a large and growing body of research about effective teaching methods and make connections with students. Yet, despite the high stakes now associated with undergraduate education, most institutions pay too little attention to these findings." She added that a second important component of the teaching quality equation is the faculty workforce situation. The report highlights that at least half of all instructional faculty in higher education, including upwards of 80% at community colleges, is delivered by non-tenure track, short-term faculty members. She stated that this is largely an economic decision by institutions. These faculty earn less, have fewer benefits, and generally are not provided offices in which to meet students. She said the report argues that effective teachers should be able to build successful professional lives, based, in part, on more stable workplace conditions. Although, she did say that the report does not equate this stability, necessarily, with tenure.

Dr. Baum continued the presentation by shifting to the issue of affordability. She stated that most of the discussion today is on how to make education cheaper. She argues, however, that an education is not affordable, no matter how cheap it is, if it doesn't have value and if it doesn't lead both to improvements in peoples' lives and in their labor force opportunities. To that end, she noted that getting a degree that is not relevant to the current job market, does not bring return on educational investment.

Dr. Baum continued by addressing the role completion rates play in affordability. She noted that students who leave an educational institution with nothing to show for their efforts but a sizeable education debt, but no degree, are far more likely to fail the "value test" of education. She said this leads to a conversation about how the system counsels students about what to study, where to study, when to study. She pointed out that the value of a targeted two-year degree can be much more valuable than a four-year bachelor's degree. The challenge is getting guidance counselors to move away from the model that says "going to college" means a four-year degree.

Dr. Ball then opened the floor to questions and discussion. Dr. McCrary began by asking the panelists to comment on the issue of apprenticeships, as an alternative to post-secondary degree granting programs. Dr. Purcell responded that the idea of apprenticeships is promising. She added that a combination of work study and academic learning is also an idea gaining popularity. Dr. McCrary reacted to this by pointing out that many years ago the four-year experience included a number of co-op programs that did just that, combine work study with classroom academics.

Dr. Peterson made the point that the decision point for many students wanting to pursue STEM degrees was very early in their schooling career, perhaps as soon as eighth grade. He noted that, without this commitment, the student would not have taken the necessary preparatory work in the math and science fields to be successful at the undergraduate level. Dr. Ball responded that, in many cases, it is not the student making those choices, but rather counselors and teachers making determinations about what they feel is best for individual students.

Dr. Córdova added that one of the challenges with implementing the many best practices identified in this report, as well as in other reports on education and teacher training, is that there is no central repository where these findings and recommendations are housed, tracked, and searchable. Related to this, she continued, is the lack of in-depth research on the connection between educational programs and outcomes. She said that there is an assumption that if a student is in a learning experience, then it is a good program and good outcomes will result. She further suggested that perhaps this is an area in which NSF could make substantive contribution by funding research.

Dr. Purcell responded that research actually shows that narrow technical training alone often leads to a positive labor outcome, but less than stellar broader societal skills achieved through more general liberal arts education programs. Her recommendation was that there is value in combining the two.

Dr. Cerf contributed the point that it is important for students to be able to try things early in their educational career, not just be told about them. His point was that people are happiest if they do something they enjoy doing that they are good at doing. He also stated that there is a need to move beyond that notion that you go to school to get trained or educated in some discipline or skill and your education is done. In fact, he argued that learning is a life-long

endeavor and increasingly essential for survival in the rapidly and constantly changing technological world in which we live.

Dr. Zuber added that one additional challenge for students is to know where to find information about educational choices and related labor outcomes. If a student takes on thousands of dollars in student loans and then cannot find a job following graduation because the degree is not marketable, has that been a positive education experience? Dr. Baum responded that there are a number of databases at the Department of Education that can inform those decisions, but, she argued, is it wise to measure the value of higher education entirely in terms of jobs and money?

Dr. Lineberger built on the comments by Dr. Peterson and Dr. Cerf asking the question, “What can we do at a very young age that gets you to love something?” Dr. Peterson said that part of the solution at Georgia Tech University has been the expansion of summer programs for students in grades five through eight. He stated that this has accomplished two things. First, it has exposed children, who may not otherwise have had that opportunity, to STEM-related activities. Second, and related, the exposure has helped those same students make the early decisions he spoke of earlier to enroll in the math and science track in high school so they are competitive for STEM curricula in college.

With no additional questions, Dr. Zuber adjourned the meeting, to be reconvened at 1:15 p.m. following the lunch break.

### **Session 3**

Dr. Zuber reconvened the Plenary session at 1:15 p.m. on February 22, 2018.

## Chair’s Remarks

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Dr. Zuber welcomed the NSF staff, guests, and members of the public listening via webcast. She began her remarks by recognizing notable achievements by Board members since the last meeting. She started by echoing Dr. Córdova’s congratulations to Dr. Arthur Bienenstock on his receiving AAAS’ 2018 Philip Hauge Abelson Prize. She then recognized Dr. Deborah Ball’s receipt of the 2017 Felix Klein Award from the International Commission on Mathematical Instruction. Dr. Ball was recognized for her outstanding contributions and her leadership role in deepening our understanding of the complexities of teaching mathematics and in improving the practice of teaching and of teacher education. Dr. Zuber continued by congratulating Dr. France Córdova for her induction to the U.S. News STEM Leadership Hall of Fame. She is being honored as a STEM leader who has achieved measurable results in the science, technology, engineering and math fields; challenged established processes and conventional wisdom; inspired a shared vision; and motivated aspiring STEM professionals. Next, Dr. Zuber announced the election of Dr. Sethuraman Panchanathan as a Fellow of the American Association for the Advancement of Science. He is being recognized for distinguished contributions to the field of human-centered multimedia computing and for national leadership in research, science, technology, and innovation. Finally, Dr. Zuber congratulated Dr. Geraldine Richmond on her election to be President-elect of Sigma Xi, the Scientific Research Honor

Society. Dr. Zuber went on to acknowledge the service to NSF of Mr. Michael Sieverts upon his retirement from the Foundation.

## Director's Remarks

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Dr. Córdoba began by announcing one more honoree. She reported on a special conference held at California Tech in December 2017 entitled, *The Origin of Galaxies, Stars, and Planets in the Era of ALMA*, organized to honor NSB member Dr. Anneila Sargent. She continued by advising Board members that a written update from Amanda Greenwell on Legislative and Public Affairs was in the Board Book and reminding them of the recent publication of OLPA's Green Book, *Transforming the World Through Science*.

Dr. Córdoba then announced new senior staff moves and additions across the Foundation. Ms. Teresa Grancorvitz assumed her new position Chief Financial Officer in January. Dr. James Ulvestad became the Foundation's first Chief Officer for Research Facilities in January. Dr. Scott Borg assumed the role of Deputy Assistant Director for the Directorate for Geosciences in December 2017. Dr. Linda Blevins became the Deputy Assistant Director for the Directorate for Engineering, also in December. Dr. Manish Parashar became the Office Director for the Office of Advanced Cyberinfrastructure in the Directorate for Computers and Information Science and Engineering in January. Dr. Juan Meza assumed the position of Division Director for the Division of Mathematical Sciences in the Directorate for Mathematical and Physical Sciences in February.

## Approval of Prior Minutes

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Dr. Zuber presented the minutes of the [November Open Plenary](#) for approval. Those minutes were approved as presented.

## Open Committee Reports

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Dr. Zuber then turned to the open committee reports, noting that the full record of committee activities would be detailed in the respective committee minutes.

Dr. Richmond reported that the National Science and Engineering Policy (SEP) Committee had shared outcomes of the recently held SEP Retreat, with a focus on the *Indicators* publication. As a result of the retreat, NCSES is due to report back to the Committee in May with a more detailed plan for reimagining the *Indicators* report. Dr. Richmond said the Committee also discussed producing a second policy companion statement for *Indicators 2018*. There were four topics suggested with support for all four in varying degrees. She recommended that the topic for this next statement would be "The State of US Science Enterprise Risks and Opportunities for Globalization of Science and Engineering." This recommendation was approved.

Dr. Panchanathan reported for the Committee on Strategy (CS). He stated that the CS heard a status update on the FY 2018 appropriations and the FY 2019 budget request.



Dr. Lepage reported that the Committee on Awards and Facilities (A&F) heard a presentation on community engagement for the NEON facility. The Committee also heard a report from the Board members who visited Antarctica following the November meeting. Dr. Lepage also said that there would be a full committee conference call to discuss the Congressionally-requested report on NSF Operations and Maintenance planning.

Dr. Jackson represented the Committee on External Engagement (EE) and reported that the Committee heard a report on the *Indicators 2018* rollout activities. He also stated that the Committee recommended that the next Board listening session be held at Macomb Community College in Michigan, outside Detroit, with a second session at Florence Darlington Technical College in Florence, South Carolina later in the year. He noted that both locations have ties with NSF's Advanced Technological Education program. Dr. Jackson also reported that Dr. Panchanathan had volunteered to host a Member of Congress at Arizona State University.

Dr. Anderson reported for the Committee on Oversight (CO). He reported the committee discussed merit review topics related to success rates, proposal quality, and geographic distribution of NSF funding. The Committee proposed questions it would like to consider under each topic for a more detailed analysis. He also reported that Assistant Inspector General Mark Bell presented the NSF management challenges. CO also heard a briefing from David Zavada from Carnie and Company who presented the results of the financial statement audit and the Federal Information Security Management Act review. Dr. Anderson noted that a written update from the Chief Financial Officer was also received with no action required.

Dr. Victor McCrary reported on the work of the Skilled Technical Workforce Task Force. He reported on the presentation received from Lisa Gevelber, from Google, on their Grow with Google Initiative.

## Discussion of NSF's Implementation of AICA

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Dr. Zuber concluded the business portion of the meeting by handing the floor to Director Córdova, who introduced Dr. James Ulvestad and Dr. Wanda Ward to present on NSF's implementation of the American Innovation and Competitiveness Act (AICA).

Dr. Ward began by noting that the AICA impacts other agencies beyond NSF, to include NIST, NASA, and OSTP. She added that it had not changed how NSF does business. She stated that the Act affirmed and enhanced NSF's management and operations. It also provided a strong affirmation from Congress of the two merit review criteria [intellectual merit and broader impacts] used for making research awards. Dr. Ward continued by highlighting the Director's commitment to take an agency-wide approach to ensure fulfillment of the requirements in a timely and quality fashion. She said the Director established the AICA Coordinating Committee shortly after the Act was enacted to facilitate the creation of an internal, agency-wide, action plan. Dr. Ward stated that the action plan addresses each of the AICA's approximately 35 sections. She added that this collaborative effort allowed the agency to meet the one-year deadline for submitting reports and letters of notification on NSF's progress toward meeting the Act's requirements. Significant among those was the strengthening of oversight over major multi-user facilities. Dr. Ward noted the January appointment of Dr. James Ulvestad as the agency's first Senior Agency Official, identified at NSF as the Chief Officer for Research

Facilities (CORF), as the response to that requirement. She then passed the floor to Dr. Ulvestad for his discussion of his new role.

In defining his role in the newly created position, Dr. Ulvestad explained that he is not in charge of the Large Facilities Office and all NSF facilities do not report to him. But rather, he stated, his new role is to ensure that oversight is integrated at a high level, that it's uniform across NSF, that the Office of the Director is fully in the loop. In response to critics who suggest his new position is simply adding another layer of bureaucracy to the facilities enterprise, Dr. Ulvestad stated that it is not adding bureaucracy, but rather clarifying roles and responsibilities between existing oversight structures, reducing overlap, and filling identified gaps. He added that he is also responsible for keeping clean lines of communication open between the Divisions, Directorates, and the Office of the Director. He stated that he sees success, in part, as ensuring there are no surprises in terms of policies on paper actually being followed.

The floor was then opened for discussion.

Dr. McCrary began by asking if Dr. Ward had any information on the progress the other agencies had made in fulfilling AICA, such as NIST, OSTP, etc. Dr. Ward stated that, while she would not speak for the other agencies, Dr. Córdova's testimony partner at the table was Undersecretary Copan from the Department of Commerce and Director of the National Institute of Standards and Technology. Of the myriad of sections included in the AICA, NIST had the second largest number to address. She also added that OSTP does not have very many items to address in the AICA.

Dr. Bienenstock asked about the status of the interagency working group on administrative burdens that is called for in Title II of the AICA. Dr. Ward responded that NSF is a full partner in this process and representatives have attended a number of meetings. Dr. Ulvestad added that the National Science and Technology Council is in the process of reformulating its committee structure and the working group is a part of that process, so clear updates may be a couple of months away.

There being no further comments or questions, Dr. Zuber ended the discussion.

## Chair's Closing Remarks

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Dr. Zuber closed the meeting by reminding everyone about a public briefing on *Science and Engineering Indicators 2018* that would take place in the Board Room at 3:00 p.m. She also announced that the Board office would be conducting a poll for preferences to deal with the anticipated extraordinary full agenda for the May meeting. There being no further business, Dr. Zuber adjourned the meeting at 2:00 p.m.

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Dr. Brad Gutierrez  
Executive Secretary, NSB  
Signed by: BRAD A GUTIERREZ

