Section B: Data Collection Procedures and Statistical Methods

Part B of the Supporting Statement for the Evaluation of the CCI study covers Data Collection Procedures and Statistical Methods. The data collection instruments described in this submission include the Survey and Interview protocols (See Appendices 1 and 2).

B.1. Describe (including a numerical estimate) the potential respondent universe and any sampling or other respondent selection methods to be used. Data on the number of entities (e.g., establishments, State and local government units, households, or persons) in the universe covered by the collection and in the corresponding sample are to be provided in tabular form for the universe as a whole and for each of the strata in the proposed sample. Indicate expected response rates for the collection as a whole. If the collection had been conducted previously, include the actual response rate achieved during the last collection.

Since this is a new data collection and we do not have an actual response rate from previous collection efforts, the estimates for response rates are based on estimates for similar projects that Abt has conducted.

Surveys. Two online surveys are proposed for the study: CCI Principal Investigator (PI) and Co-Investigator (Co-I) Survey and CCI Graduate Student and Postdoctoral Researcher Survey. Both surveys will be administered to current and recent former U.S.-based participants of all Phase I and Phase II grants awarded between 2010 and 2016. To minimize possible recall bias and to ensure that respondents have sufficient experience with CCI, the samples will be limited to PIs and Co-Investigators who were included in annual reports between the 2012-13 and 2016-17 reporting years and graduate students and postdoctoral researchers who were included in annual reports between 2014-15 and 2016-17. Applying these criteria results in samples of 211 PIs/Co-Investigators affiliated with 14 CCIs (5 Phase I-only and 9 Phase I/II) and 859 graduate students/postdocs affiliated with 9 Phase II CCIs. The surveys will be administered to all individuals in this sample (a census). Since this is not a mandatory collection, we expect to have some level of nonresponse, approximately 20 percent, resulting in an 80 percent response rate. Non-respondents will include people who choose not to complete the survey and people for whom it was not possible to update contact information and thus who could not be reached.

Interviews. The evaluators propose interviews with three types of respondents: PIs on CCI grants, Co-Investigators on CCI grants, and industry partners. Abt will use a convenience sample for interviews.

- For the CCI PI and Co-Investigator interviews, all 9 primary PIs on Phase II grants and a sample of up to 18 Co-Investigators on Phase II grants will be included. Abt will select Co-Investigators based on recommendations from the PI, survey data, and administrative data. In particular, the Co-Investigator interview sample will include individuals with a range of project activities and duration of Center participation. Abt expects a 100 percent response rate.
- For the industry partner interviews, Abt will draw a sample based on administrative data and recommendations provided by each CCI PI for several industry partners that were involved with the center to such a degree that they would be able to provide useful feedback. The industry partner sample will include a range of industries, if possible. Approximately 10-15 individuals will be interviewed. Abt expects a 100 percent response rate.

Locating respondents. Respondent contact information will be extracted from the most recent annual report in which it is available. For any emails that bounce back when Abt sends out the pre-survey notification (see B.3), an attempt will be made to identify an alternative address through internet searches.

B.2. Procedures for the Collection of Information

B.2.1. Statistical methodology for stratification and sample selection.

The surveys of CCI PIs, Co-Investigators, graduate students, and postdoctoral researchers will include the census of 211 PIs and Co-Investigators affiliated with 14 CCIs (5 Phase I-only and 9 Phase I/II) listed in annual grant reports between the years 2012-13 and 2016-17, and 859 graduate students and postdocs affiliated with 9 Phase II CCIs listed in annual grant reports between the years 2014-15 and 2016-17. Survey protocols are included in Appendix A and C.

The interviews are not intended to yield representative population estimates and thus respondents will be selected based on a recommendation of CCI PIs, program data, and survey data. Interview protocols are included in Appendix B and D.

B.2.2. Estimation procedure.

Not applicable.

B.2.3. Degree of accuracy needed for the purpose described in the justification.

The expected 80 percent survey response rate will lead to estimates with a high degree of accuracy even if non-response bias is present. Survey responses will be triangulated with administrative data as a further check on accuracy. Nevertheless, a high degree of accuracy is not required for the purposes described in this justification. The purpose of the evaluation is to explore the outputs and outcomes of the CCI program, not assess impact or causation or generalize survey responses to all center-based programs.

B.2.4. Unusual problems requiring specialized sampling procedures.

Not applicable.

B.2.5. Any use of periodic (less frequent than annual) data collection cycles to reduce burden.

Not applicable.

B.3. Methods to Maximize Response Rates and Deal with Nonresponse

Since this is the first evaluation of NSF CCI and there are no prior CCI studies to draw from, the study team used the knowledge and lessons learned from prior NSF evaluations to design instruments that will be clear and relevant to CCI participants. The study team completed two previous rounds of pretesting of the online survey to ensure that participants can complete the survey efficiently without any glitches or technical issues.

One challenge of this study will be motivating participation and following up with initial non-respondents to achieve our target response rate of at least 80 percent. The web-based approach will allow us to easily identify non-respondents for follow-up contact to encourage participation and maximize response rates. To increase the overall survey response rate, follow-up with respondents will be multi-modal (email and telephone).

Specifically, we will use the following methods to encourage participation (survey and interview requests and reminders are included with instruments in Appendices A-D):

- **Pre-study notification from NSF to PIs**. NSF will send a letter to PIs introducing the team at Abt Associates and informing them about the goals of the CCI evaluation. This email will add credibility to the email solicitation that will come from Abt a day later to encourage participation and increase study response rates.

- **Pre-study notification from Abt to PIs**. Abt will email PIs with a list of potential study respondents to notify and request their participation. We will personalize the email invitations by addressing each PI by name by using MS Word's mail merge tool. In addition, we will also include the name of the NSF contact and a survey administrator contact so that participants may ask questions about the study.

- **Pre-study notification from Abt to study participants**. Abt will email potential study respondents to inform them about the goals of the CCI evaluation and request their future participation. Abt will look for updated email addresses for any participants whose emails bounce back.

- **Survey request email from Abt to study participants.** At the designated opening date, the study team will send an email message to respondents with a unique survey link, detailed instructions, the closing date, and project staff contact information. Detailed on-screen instructions will be included. Throughout the data collection cycle, the study will use an email address to ensure that potential respondents can quickly and easily obtain answers to questions or concerns.

- **Personalized reminder emails**. A personalized reminder email will be sent to study participants approximately two weeks after the initial invitation to encourage anyone who has not yet participated and to thank those who completed the survey. Additional reminder emails will be sent to non-respondents weekly.

- **Final reminder email**. A final reminder email will be sent to participants 48 hours before the close of the survey to again remind those who have not yet participated and to thank those who completed the survey.

Abt expects a survey response rate of at least 80 percent and will implement follow-up procedures with non-respondents to increase participation. If survey response is less than 80 percent, two types of analyses will be performed to assess the implications of non-response. First, the available characteristics of individuals who completed the surveys (Center affiliation, project role, number of years of Center participation) will be compared to the characteristics of those who did not. Second, a statistical test using these baseline characteristics will be performed to predict the probability that a project participant was located and responded to the survey request. If these analyses point to the possibility of non-response bias, sampling weights will be created based on the observable baseline characteristics and used in frequency calculations.

B.4. Describe any tests of procedures or methods to be undertaken. Testing is encouraged as an effective means of refining collections of information to minimize burden and improve utility. Tests must be approved if they call for answers to identical questions from 10 or more respondents. A proposed test or set of test may be submitted for approval separately or in combination with the main collection of information

The survey instruments and interview protocols developed for this data collection were pilot-tested under Fast Track Clearance 3145-0215.

The survey instruments were programmed and subjected to two rounds of pretesting. First, Abt researchers followed a pre-determined script to ensure that all skip patterns and open-ended and multiple-choice questions worked as intended. Any glitches identified through this process were fixed before piloting the survey on a small number of subjects chosen to represent the study populations. For the pilot test, 36 graduate students and postdocs and 15 PIs and Co-Investigators were selected using purposive sampling to participate. These individuals were asked to provide feedback on the clarity and content of the questions and the time it took them to complete the survey.

Abt received 15 responses from graduate students and postdoctoral researchers and 9 responses from PIs/Co-Investigators. The median response time (inclusive of pilot feedback questions) was 15 minutes for both surveys. These burden estimates include the time to answer each question and provide feedback, and therefore likely exceed the actual time it will take to complete the surveys. Thus, the estimates of burden provided in section A.12 are conservative. Since we expect some PIs and Co-Investigators, particularly those who were involved in the program for numerous years, may spend more time responding to the survey, we estimate their burden at 20 minutes.

All of the CCI pilot testers reported that the survey instructions were easy to follow, and the questions were asked in a logical order, were clearly worded, and were easy to answer. The total number of questions was considered appropriate.

Pilot testers identified a handful of survey questions that were not applicable to their experience, or that could use additional or slightly different options; the surveys were adjusted based on this feedback. Exhibits 6 and 7 show the comments from the testers and the corresponding revisions to the PI/Co-Investigator and the graduate student/postdoctoral researcher surveys, respectively. Note that identifying information (center names and primary PIs) in the feedback has been redacted to protect respondents' privacy.

Exhibit 6. PI/Co-Investigator Pilot Feedback and Revisions

Original Question	Feedback	Revision
2. All of the questions in the survey refer to your participation in the following NSF Center for Chemical Innovation (CCI): [CCI name]. Please note that your center may have been funded under a predecessor to the NSF CCI program such as Chemical Bonding Centers (CBC). ☐ I have participated in this CCI ☐ I have participated in a different CCI → A ☐ I have not participated or I am not sure whether I participated in the CCI program A. Please select from the list of options If you participated in more than one CCI, please select the CCI with which you have been most extensively involved. [pull-down menu of CCIs]	"I know what you mean here, so I checked the first one, but I have been a member of two CCIs: [CENTER A] (as a PI) and [CENTER B] (as a postdoc). So, I could click both of the first two choices."	Revised question text and response options 2. All of the questions in the survey refer to your participation in the following NSF Center for Chemical Innovation (CCI): [CCI name]. Please note that when first established, the program was called the Chemical Bonding Centers. ☐ I have participated in this CCI ☐ I have not participated in this CCI, but I have participated in a different CCI → A ☐ I have not participated or I am not sure whether I participated in the CCI program A. Please select from the list of options If you participated in more than one CCI, please select the CCI with which you have been most extensively involved and limit your answers to this CCI only. [pull-down menu of CCIs]
3. What is your role in this CCI? Select one.	"OK, now I'm confused. Internally, in all communication we have by e-mail, any member of the [CENTER] than runs a research group is called a PI. But, I assume that the NSF might view [PRIMARY PI] (the director of the [CENTER]) as the PI and the rest of us as co-investigators. Otherwise, I don't know what a co-investigator is. So, I am clicking "co-investigator" here, but I definitely think this question needs clarification. Maybe "directing/head PI of this CCI" or "co-investigator/co-PI"?"	Deleted question Project role recorded in RPPRs
5. On a scale of 1-5, where 1 indicates "not at all" and 5 indicates "very," to what extent does the research conducted by your CCI have the following characteristics?	"I do not think many would admit anything below a five or four to those questions. Who would say their work was not important and needed more money? Don't think those are useful questions"	No change made Some pilot respondents gave themselves ratings below four
10. Please indicate whether participation in the CCI has benefited your research program.	"I work at a government lab that has minimal access to students and analytical equipment used in my work."	No change made

Original Question	Feedback	Revision
11. Have any of the following changes occurred in your publication patterns, research interests, and/or professional visibility since you began participating in CCI?	"Maybe there should also be a "not applicable" choice here. We are only in our second year, and we are just starting to submit our first [CENTER] papers. Thus, it is hard to judge the impact on the quality of the journals we publish in."	Revised response options (changed "Has not changed" to "Has not changed/Too early to tell")
12. Which of the following resources/infrastructure created or improved by CCI, if any, are being used by researchers not affiliated with the center? ☐ Methods or instruments, research practice ☐ Reagents ☐ Data ☐ Communication infrastructure ☐ Educational or outreach materials ☐ Facilities or equipment ☐ Lessons learned for how to run a large center ☐ New partnerships or alliances ☐ Other resources. Please specify: __	"What is the difference between instruments and equipment? Is an instrument not equipment? Also, maybe add information infrastructure. My group is adopting the electronic data management system that the [CENTER] developed. I think it is great!" "My response to the above question only applies to my lab."	Revised response options 10. Which of the following resources/infrastructure created or improved by CCI, if any, are being used by researchers not affiliated with the center? ☐ Methods ☐ Reagents ☐ Data ☐ Communication infrastructure ☐ Data management system ☐ Educational or outreach materials ☐ Facilities ☐ Equipment ☐ Lessons learned for how to run a large center ☐ New partnerships ☐ Other resources. Please specify: __ ☐ I am not aware of any resources created or improved by CCI that are being used by researchers not affiliated with the center

Original Question	Feedback	Revision
13. Please indicate whether your CCI developed or improved the following infrastructure to develop workforce, broaden participation of underrepresented groups in chemistry, and improve public outreach, and if you expect to be able to sustain it after the grant ends.	"This prompt has two clauses/questions (1. was it developed and 2. will you be able to sustain it), but there is only one check box per item. Maybe better to ask "If this was developed, will you be able to maintain it when the grant ends?" That's how I'm answering the question"	Split question into two 11. Please indicate whether your CCI developed or improved the following educational or outreach opportunities. ☐ I do not know whether my CCI developed or improved these types of opportunities → skip 13b 12. Current grants: Please indicate whether you expect to be able to sustain the following programs and activities after the grant ends. Completed grants: Please indicate whether the following programs and activities are still in place.
14. Please indicate whether the following improvements have occurred as a result of CCI funding.	"I am a contract scientist in a government lab where I have very little influence on the institutional culture that is controlled by civil servants and their management system."	Added "N/A" response option
15. Please indicate whether the CCI delivered any of the following benefits to industry.	"Is this my opinion of whether the [CENTER] was able to accomplish each benefit or whether I personally participated/achieved each benefit? If the former, there should also be a column for "not sure". For a lot of these, I have no idea but that is not an option." "Don't know about increase in sales or cost savings" "I'm not sure how relevant these are for [CENTER]. Possibly on the experimental side but not yet in my direct projects."	Added "Uncertain" response option Added checkbox to skip question 14. Please indicate whether the CCI delivered any of the following benefits to industry. ☐ I am not aware of any partnerships between my CCI and industry → skip to next question
19. Phase II only: To what extent has participation in Phase I contributed to the success of your Phase II center? ☐ Not at all ☐ To some extent ☐ To a considerable extent	"Consider adding an "n/a" option. I did not participate in Phase I, so there is no option for me." "I did not participate in Phase 1."	Added checkbox to skip Phase I impact questions 20. Phase II only: To what extent has participation in Phase I contributed to the success of your Phase II center? ☐ I did not participate in Phase I → skip Phase I impact questions ☐ Not at all ☐ To some extent ☐ To a considerable extent

Original Question	Feedback	Revision
20. Have any of the following occurred as a result of your participation in Phase I? Would these outcomes be more challenging to achieve under a 1-phase center model?	"Consider adding "I did not participate in Phase I" instead of just "no benefits"" "I did not participate in Phase 1."	Addressed above
Overall Feedback	"Add an NA to all questions"	Added N/A An N/A option encourages low-effort responses, so we added it only where we believed a particular question may not be applicable to certain respondents.
Overall Feedback	"I think some of the questions need clarification because different co-PIs have different roles and involvement, but overall, I think the survey is good"	No change made However, we did add "N/A" and "Uncertain" response options where warranted.

Exhibit 7. Graduate Student/Postdoctoral Researcher Pilot Feedback and Revisions

Original Question	Feedback	Revision
2. All of the questions in the survey refer to your participation in the following NSF Center for Chemical Innovation (CCI): [CCI name]. Please note that your center may have been funded under a predecessor to the NSF CCI program such as Chemical Bonding Centers (CBC). ☐ I have participated/still participating in this CCI ☐ I have participated/still participating in a different CCI → A ☐ I have not participated in the CCI program A. Please select from the list of options If you participated in more than one CCI, please select the CCI with which you have been most extensively involved. [pull-down menu of CCIs]	"I didn't know there were a Chemical Bonding Centers. Otherwise it is clear about my particular involvement with the [CENTER]"	Revised question text and response options 2. All of the questions in the survey refer to your participation in the following NSF Center for Chemical Innovation (CCI): [CCI name]. Please note that when first established, the program was called the Chemical Bonding Centers. ☐ I have participated/am still participating in this CCI ☐ I have not participated/am not participating in this CCI, but I have participated/am still participating in a different CCI → A ☐ I have not participated in the CCI program A. Please select from the list of options If you participated in more than one CCI, please select the CCI with which you have been most extensively involved and limit your answers to this CCI only. [pull-down menu of CCIs]

Original Question	Feedback	Revision
11. Which of the following positions are you most interested in pursuing after you complete your degree and/or postdoctoral training? Have your career goals changed since you began participating in the CCI? ☐ Faculty member in a research college or university ☐ Faculty member in a 2-year or 4-year teaching college ☐ Program officer/academic administrator ☐ Non tenure-track researcher in a university or a research institute ☐ Researcher in a government laboratory ☐ Research and Development position in industry ☐ Business position in industry or an entrepreneur ☐ Other, please specify: _____	"This page doesn't reflect non-traditional career paths such as science writing or consultation."	Added response option 12. Which of the following positions are you most interested in pursuing after you complete your degree and/or postdoctoral training? Have your career goals changed since you began participating in the CCI? ☐ Faculty member in a research college or university ☐ Faculty member in a 2-year or 4-year teaching college ☐ Program officer/academic administrator ☐ Non tenure-track researcher in a university or a research institute ☐ Researcher in a government laboratory ☐ Research and development position in industry ☐ Business position in industry or an entrepreneur ☐ Science policy, law, consulting, or science writing ☐ Other, please specify: _____

Original Question	Feedback	Revision
12. Have you spent time working in a laboratory/research group of a CCI partner organization (as an intern, graduate student, visiting scholar, or similar)? 12A. Which of the following best describes the organization(s) in which you worked? Select all that apply if you worked with more than one type of organization. 12B. How much time did you work at CCI partner organization(s) in total? 12C. How valuable was this experience to your career development? ☐ Not at all valuable ☐ Somewhat valuable ☐ Very valuable	"Not really sure what you mean by partner organization. Is this the universities which are part of the CCI, which are not my own? or something else? I am going to assume so, and answer yes. Perhaps explain in more detail or give examples?" "It would be easier to answer this page with options that indicate if you are still involved with the CCI." "Adding an "I'm not sure" option would be a more accurate answer."	Revised question text and response options 13. Have you spent time working in a laboratory/research group of the CCI partner organization (e.g., another university or company involved with your center) as an intern, graduate student, visiting scholar, or similar role? 13A. Which of the following best describes the organization(s) in which you worked and/or currently work? Select all that apply if you worked with more than one type of organization. 13B. How much time did you work at CCI partner organization(s) in total? 13C. How valuable was this experience to your career development? ☐ Not at all valuable ☐ Somewhat valuable ☐ Very valuable ☐ Too early to tell/uncertain
16. How well do you think participation in the CCI has prepared/is preparing you for the following activities?	"This form is answered to reflect what I know my specific involvement with the center has prepared me for. One-on-one interactions with research advisors would reflect different answers to these same questions"	Changed "N/A" response option to "N/A/too early to tell"

The interview protocols were subjected to a round of pilot testing. Four Phase II Co-Investigators and two Industry Partners participated in the pilot. The median response time was 60 minutes for Co-Investigator interviews and 30 minutes for Industry Partners interviews. The questions in the PI/Co-Investigator interview protocol were clear and relevant to all pilot Co-Investigators. Pilot industry partners had difficulty providing detailed responses to three of the questions in the Industry Partners interview protocol given the nature of their involvement with the CCIs. The three questions are:

1. What do you see as the most important scientific and engineering accomplishments of the Center? Do you think these accomplishments would have been possible without the Center structure? If not, how were these accomplishments enabled by the Center?

2. What do you see as the most important non-scientific accomplishments of the Center (e.g. in workforce development, knowledge transfer, educating the general public)? Would they have been possible without the Center? If not, how were these accomplishments enabled by the Center?

3. Do you have a view about the Center organization and processes? Do you think these are effective? Are there components you would change?

We removed these three questions from the Industry Partners interview protocol. Given that these three questions represent one-third of the questions in the piloted protocol, we estimate the burden of the final protocol at 20 minutes (two-thirds of the median pilot response time).

B.5. Individuals Consulted on Statistical Aspects and Individuals Collecting and/or Analyzing Data

The contractor for collection and analysis of data in this study is Abt Associates. Staff from Abt Associates, the contractor performing the study, have all necessary experience to complete this data collection. Allan Porowski, the Project Quality Advisor, is an evaluation methodologist who has substantial experience with survey research. Ellen Bobronnikov and Luba Katz, the Management and Technical Leads have each designed and administered numerous surveys for NSF as well as other federal agencies, and Brian Freeman, the Director of Analysis, has a background in statistics and has designed numerous federally funded surveys and analyzed their data. In addition, the data collection instruments and procedures have been reviewed by NSF staff familiar with the program and by the external Technical Working Group described in section A.8.

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