University of California, Santa Barbara
Donald Bren School of Environmental Science & Management

Current Environmental Health and Safety Practices in the Nanomaterial Industry

A Group Project Proposal
submitted in partial satisfaction of the requirements for the degree of
Master’s of Environmental Science and Management

By

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22 June 2006
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I. ABSTRACT

At this early stage of nanotechnology’s development, guidance from governments on how engineered nanomaterials should be handled to minimize their potential risks is just evolving. This research project aims to understand what steps producers and users of engineered nanomaterials are taking to ensure the safety of workers, customers, the public, and the environment from the potential risks of these materials. The project focuses on risk management practices, that is, the steps producers and users are taking to reduce the potential hazards or exposures associated with engineered nanomaterials.

We will review current initiatives to develop recommendations on the safe manufacture and use of engineered nanomaterials. Then we will propose a systematic assessment of current practices through the collection of interview and web-based survey data from more than forty-five nanotechnology research institutions and companies worldwide. Our research will discern how producers and users are deciding which potential risks to address through management practices and what assumptions about the potential hazards of nanomaterials they are making. We will focus on the actual practices they employ to minimize those potential risks. Finally, we will analyze the results of our survey in order to contribute to the knowledge-base of nanomaterial safety, closing knowledge gaps and developing recommendations for “best practices” in the nanotechnology field. The final product will be a report of our findings that will be delivered to our funding agency, the International Council on Nanotechnology, to assist with the development of worldwide nanomaterial safety standards.

II. EXECUTIVE SUMMARY

Nanotechnology is the study and application of engineered materials designed and produced to have structural features with one or more dimensions between 1 and 100 nanometers. In this size range, materials exhibit novel or enhanced chemical and physical properties that can enable a wide range of technological applications, ranging from faster computer chips to new ways of treating cancer. In the United States, the organization of diverse research activities under the National Nanotechnology Initiative has led to one of the largest government investments in physical sciences research since the space program. The field of nanotechnology has captured the imagination of scientists and non-scientists alike who see the potential to create benefits that could touch the lives of people everywhere.

At the same time, however, the novel nanostructure-dependent properties (e.g., chemical, mechanical, electrical, optical, magnetic and biological) which make engineered nanomaterials desirable may also pose new risks to workers, consumers, the public and the environment. As noted in an October 6, 2005 report by The International Life Sciences Institute Research Foundation/Risk Science Institute,
“these same properties potentially may lead to nanostructure-dependent biological activity that differs from and is not directly predicted by the bulk properties of the constituent chemicals and compounds.”¹ The report went on to state that “existing research raises some concerns about the safety of nanomaterials.”²

The International Council on Nanotechnology (ICON) is concerned with environmental and health risks of nanotechnology. They contribute to understanding and minimizing potential risks while maximizing the societal benefits of nanotechnology by promoting international activities that lead to responsible risk assessment, management, and communications. ICON believes that a proactive approach to sustainability and safety will only enhance the value of the nanotechnology enterprise to both industry and the world’s citizens. Our efforts are founded on the belief that partnership activities between governments, industry, academia and non-governmental organizations are the key to a green nanotechnology industry.

ICON initially released a request for proposals in December of 2005. ICON selected and funded our proposal to review current initiatives on developing recommendations on the safe production and use of engineered nanomaterials, and to survey and analyze current practices being used to manage potential environmental and health risks from production to disposal. Our research will focus on risk management practices employed by companies that produce or use engineered nanomaterials, but will also include insights from practices used in government or academic research laboratories. Our research will provide a summary and analysis of current practices which considers the full life-cycle of nanomaterials, including research and development, production, use, and disposal. We will also identify differences in risk management practices based on material type, application, and amount used. The ultimate goal of this research is to produce a report on the current “best practices” for ensuring environmental and occupational safety when producing or using engineered nanoparticles, including an analysis of the limitations of current practices, research needed to address these limitations and current initiatives seeking to develop more appropriate recommendations on the safe production and use of engineered nanomaterials.

Assessment of current practices in nanomaterial environmental health and safety (EHS) will be conducted through literature searches, a web-based survey and telephone interviews with researchers, manufacturers, and users of nanomaterials. The ICON Best Practices working group will assist by providing initial lists of reports for review, developing target lists for interviews, and setting up initial contact with


² Ibid., page 4.
some interview targets. The UCSB research team will develop a detailed work plan for review and approval by the ICON steering committee.

The project will proceed in two major phases, as outlined below. ICON will review the results of Phase One before research proceeds with Phase Two. The scope of Phase Two will be adjusted according to the findings from Phase One. The aim is to create a survey and define a research scope that will fill existing knowledge gaps.

III. BACKGROUND INFORMATION

Nanotechnology is the understanding and control of engineered materials at dimensions of 1 to 100 nanometers, i.e. at the “nanoscale.” Nanomaterials are designed to exhibit novel or enhanced properties that affect their physical and chemical behavior, in effect presenting opportunities to create new and better products. Consequently, nanotechnology has the potential to make significant contributions to many fields, ranging from semiconductors to biotechnology to energy, transportation, agriculture and consumer products. Nanotechnology also presents new challenges to improve how we measure, monitor, manage, and minimize contaminants in the environment. Already, nanomaterials are making their way into our daily lives, as they are being used in the manufacture of cosmetics, clothing, sports equipment, coatings, and electronics. It is estimated that global sales of nanomaterials could exceed $1 trillion by 2015. Jih Chang Yang, Executive Director of Taiwan’s Industrial Technology Research Institute, has stated, “We believe the marketplace is already the focal point for nanotechnology today.”

At the same time, however, the properties for which these nanoscale materials were designed may generate new risks to workers, consumers, the public, and the environment. Questions have been raised regarding the potential environmental and health effects of nanomaterials. To answer such questions, significant gaps in current knowledge must be filled.

Research into nanotechnology is rapidly advancing worldwide without a full understanding of the safety implications. Roco and Bainbridge reported that the number of workers in the field that could be impacted totals one million in the US and two million worldwide. It is therefore critical that existing knowledge related to

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nanomaterial safety be compiled, analyzed and built upon, thus filling knowledge
gaps, to ensure that development is accompanied by best efforts to protect people and
the environment around the globe. Some organizations have begun to look into such
issues. The US Environmental Protection Agency’s Nanotechnology White Paper
(External Review Draft)⁶ was released to the public in December 2005. This paper
indicates that a general disconnect between industry and government exists in the US
with regards to nanomaterial safety. Current regulations in occupational safety and
environmental protection may not apply to nanotechnologies, but the full extent of
regulatory exclusion is not well understood. There is limited information regarding
the human health effects of nanomaterials, and thus a very limited basis upon which
to evaluate current occupational and environmental safety standards. The National
Institute for Occupational Safety and Health (NIOSH) addresses the knowledge gap
in its paper, Strategic Plan for NIOSH Nanotechnology Research: Filling the Knowledge
Gaps⁷. NIOSH provides basic worker protection recommendations, but they are
based on size and not the novel properties of nanomaterials. Ultimately, they
conclude that further research is necessary to develop best practice recommendations
governing the handling of nanomaterials⁸.

Our research is a “group project” within the Donald Bren School of Environmental
Science and Management at the University of California, Santa Barbara. Serving as
part of the collaborative Master’s thesis, the group of four Bren Master’s students and
a Ph.D. candidate in Sociology are advised by a Bren School faculty member
specializing in toxicology. There are also three Co-Principal Investigators: a Bren
School faculty member whose expertise is surveying environmental performance
within industry, an anthropologist who is lead PI and Co-Director of UCSB’s NSEC:
Center for Nanotechnology in Society (CNS-UCSB), and a sociologist who is the
Director of the Institute for Social, Behavioral and Economic Research at UCSB.
The students and PIs in the group will work with the project’s client (ICON) and
other industry professionals to perform the literature searches and interviews. In
addition to the requirements of the stakeholders, the Bren School requires that the
group project be capped with a final oral and poster presentation to the Bren
community, stakeholders, and other professionals.

<http://www.epa.gov/osa/pdfs/EPA_nanotechnology_white_paper_external_review_draft_12-02-
2005.pdf>

Nanotechnology Research: Filling the Knowledge Gaps.”
<http://www.cdc.gov/niosh/topics/nanotech/strat_planINTRO.html>

to Safe Nanotechnology: An Information Exchange with NIOSH.” Unpublished manuscript.
<http://www.cdc.gov/niosh/topics/nanotech/pdfs/Approaches_to_Safe_Nanotechnology.pdf>. June
11, 2006.
IV. PRELIMINARY RESEARCH

We have performed preliminary research examining regulations and initiatives of several countries that have acknowledged the need to increase the understanding of the potential risks that nanomaterials pose. We took the initial step of researching Occupational Health and Safety organizations and other government agencies for some of the prominent countries in the nanotechnology field.

The United States has begun examining the potential risks associated with nanomaterials. The actions of the US are critical because many other countries will use domestic reports to model their regulations. The US Environmental Protection Agency (EPA) has released the Nanotechnology White Paper (External Review Draft). This document identifies a need for additional research into the potential effects of nanotechnologies on ecological and human health. The document also suggests how current legislation (Clean Water Act; Comprehensive Environmental Response, Compensation, and Liability Act; Resource Conservation and Recovery Act; Safe Drinking Water Act) could be applied towards regulating nanotechnologies and environmental hazards. The EPA identifies a disconnect between industry practices and government; the agency concludes that government must gather more data on actual practices in the workplace with regards to nanomaterial safety in order to design and implement effective safety protocols. A document released by NIOSH, Approaches to Safe Nanotechnology: An Information Exchange with NIOSH\(^9\), suggests practices and equipment for working with nanomaterials based upon their bulk properties and ultrafine size. However, the document does not suggest how risk assessment should address the novel properties of nanomaterials, nor does it examine the full life-cycle of the product. NIOSH is working on a “best practices” document which is targeted for release in 2010\(^10\).

The Canadian Centre for Occupational Health & Safety\(^11\) has begun compiling the research of others, such as the US and the UK\(^12\), on the potential risks of nanotechnology. In Asia, Japan and Taiwan are taking two different approaches to

<http://www.cdc.gov/niosh/topics/nanotech/nano_exchange.html>

<http://www.cdc.gov/niosh/topics/nanotech/strat_planINTRO.html>

\(^11\) Canadian Centre for Occupational Health & Safety

risk assessment of nanomaterials. Taiwan is collaborating with USEPA to assess risks. In March of last year, this resulted in a release of verification test and standard use protocols. In addition, Taiwan hosted the first workshop on nanotechnology risk and related issues. On the other hand, Japan’s occupational safety and health agencies are designing surveys to determine the acceptance of nanotechnology.

The European Agency for Safety and Health at Work is not publicly addressing the risks of nanomaterials. However, individual efforts appear to be addressing the issue. Nanoforum.org is an organization that is compiling and performing research on behalf of the European community. In addition, several countries are initiating their own research into these risks. France is producing two documents for release in early 2006 that discuss the potential risks. The UK has also released several documents pertaining to nanomaterials and assessing their risk. In 2004, The Royal Society and The Royal Academy of Engineering released Nanoscience and nanotechnologies: opportunities and uncertainties. This document discusses possible adverse human and environmental health issues related to nanomaterials. In addition, the document poses questions and recommendations for the regulation of these materials. In response to this document, the Department for Environment Food and Rural Affairs released Characterizing the Potential Risks Posed by Engineered Nanoparticles. This document addresses some of the potential environmental and human health impacts of nanomaterials, as well as suggests areas where there is a knowledge gap.

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14 Ibid., page 6.


Based upon a document released early last year, *Nanotechnology: Enabling Technologies for Australia Innovative Industries*\textsuperscript{21}, Australia does not appear to be as cautious about the risks of nanomaterials as other developed countries. It acknowledges that there may be risks and proposes following the research of other countries regarding issues of regulation. It also advises establishing a regulatory framework to protect the health and safety of Australians.

On an international level, the International Life Sciences Institute has released a document\textsuperscript{22} examining methods which could be used to devise a strategy to assess individual nanomaterials for their toxicity to humans. This document provides an outline of various research, techniques and tools that would aid in understanding these effects.

Based on our preliminary research, it is evident that a strong need exists for a global review and analysis of nanomaterial risk assessment in order to aid the development of effective safety standards.

V. SIGNIFICANCE OF PROJECT

Simultaneous efforts are underway worldwide that are aimed at evaluating applicability of current regulations and delineating current practices in the nanotechnology industrial workplace with the nanotechnology safety hazards. However, a comprehensive repository of these efforts and their results does not exist. In order to design “best practices” and regulations, available knowledge about current safety practices in industry should be compiled and analyzed. That is the aim of our research. We will investigate and summarize current health and safety practices in the nanomaterial industry worldwide. Where safety practices are not established or are non-routine, we will try to determine what is lacking that may account for the relative absence of standardized safety practices in the workplace.

VI. APPROACH

This project will be implemented in two phases. Phase One of the project will be a multi-country secondary survey of the “best practices” development efforts for nanomaterial risk management based on existing data, reports, publications, web


materials, and expert interviews. Upon completion of the initial phase, data will be summarized and reviewed, and an initial report of our findings will be generated. The second phase of this project will examine current industrial safety practices in targeted countries for nanomaterial risk management. The ultimate goal of Phase Two is to delineate practices within industrial nanotechnology sectors, to organize the information into an understanding of how fully evolved safety practices are, and to identify critical needs for the standardization and implementation of safety practices in the nanomaterial industry for different parts of the globe.

Phase One will involve identifying and surveying literature and websites, and making direct contacts regarding completed, ongoing and planned nanomaterial safety protocol development efforts. The purpose of Phase One is to determine which organizations are currently investigating nanotechnology safety practices, how they are going about it, and what they have found. Initially, we will perform a literature review and internet searches to identify safety protocol development efforts. We will examine government and industry reports of “best practices” in the nanotechnology workplace. We want to know:

- What other organizations are undertaking the project of investigating and summarizing nanotechnology industrial safety practices?
- How are these other organizations going about their processes of information gathering?
- Are they targeting specific nanotechnology industries?
- Do they differentiate between material type (such as carbon-based, metal-based, composite, or dendrimer)?
- How global or regional is their focus?
- How are they disseminating their information or how do they plan to do so?
- What are the objectives of their development efforts?

Phase One will conclude with a report of the findings of our review, including a description of our research sources. This report will also identify current regulations pertaining to nanomaterial safety which we expect will be a context for any delineation efforts already underway. Data gathered in this first phase will be used to refine our approaches to Phase Two.

Upon completion of Phase One, ICON will review the report and then authorize the initiation of Phase Two. Phase Two will involve directly documenting current safety practices for nanomaterial risk management in the nanoscale material industrial sector. Although Phase Two will be refined and tailored to the findings of the first stage, the project will generally proceed as follows.

We will develop an interview process by which we will directly elicit responses to questions regarding current nanoscale material safety practices, primarily within the United States and European Union and secondarily in East Asia. Interviews will be conducted mainly through telephone. Attention to issues of confidentiality will be
followed closely in all phases of Phase Two research. The sample frame will be defined through purposive, or “snowball” sample techniques, beginning with informant contacts provided by ICON. Additional sources may be identified through our interviews, professional networks and internet and literature searches. Our sampling pool will include both small and large companies, government agencies, academic institutions, and experts in safe practices. We understand the importance of examining all sectors within the nanotechnology field. Industrial sectors have historically dealt differently with the risks of new technologies and we predict this will influence how they view the handling of nanomaterials. For example, the electronics industry may be better prepared to deal with hazardous wastes than designers of consumer products. In addition to delineating current practices, our survey will discover the interests, barriers, and needs of industries to implement their own practices for workplace safety. These findings will enhance our report by providing a framework for the implementation of these practices.

The elements of the interview process that are essential to its success are described below. The sample population collected for Phase Two will include at least forty five companies across the United States, Europe and East Asia. We anticipate interviewing by telephone twenty companies in the US, fifteen companies in the EU and five in East Asia. Based on our research, this will encompass eight percent of the approximately four hundred companies in the US, only a small sampling of the approximately eight hundred and fifty companies in Europe, and an even more selective set of the sixty plus companies in East Asia. To bridge the information gap in Europe and Asia, we plan to disseminate a web-based survey to more companies.

The estimated coverage of companies is based on the realistic expectations that: 1) all survey activity will occur during the summer months of 2006, 2) initial sample construction activities can begin during Spring 2006 in conjunction with Phase One research, 3) three Master’s interns working 75% time for three months in the summer can complete two surveys per student per week, 4) the weekly activities during the interview process will include proper documentation, notes, and interview transcriptions with ongoing data extraction and content analysis, 5) an initial training period during Summer 2006 is required before the above expected pace of interviewing can be accomplished, and 6) language barriers, the timeline, and the number of companies in Europe and East Asia inhibit a more comprehensive survey.

We will examine similarities and differences in practices based upon type of organization, field, region, material type (carbon-based, metal-based, composites, and dendrimers) and application (e.g., electronics, environmental, agricultural, health/medical, and cosmetics). With the comprehensive results of our research, we


seek to expand the scope of the project and critically evaluate the phrase "best practices," which we anticipate may have trivial meaning in this young field of nanotechnology. Given that existing regulations do not apply, what defines a “best practice,” and how can one know what it is? We will try to analyze current practices for effectiveness based upon our literature research and interviews with safety experts. Understanding the effectiveness of current practices will allow us to understand the limitations of current practices and provide recommendations for “best practices” based upon material type and application in the workplace. We will also examine the cost for implementation, to the extent possible, of these recommendations.

This project has been reviewed and approved by the UCSB Human Subjects Internal Review Board (HSRB). Further, all group members have successfully completed the Human Subjects Exam. We are taking steps to ensure the privacy of all survey participants by means of an internal confidentiality protocol, use of a consent form (required to be signed by all participants), and aggregation of data to disguise the identity of participants. All group members are required to sign and strictly adhere to our confidentiality protocol. This protocol consists of rules and procedures that prohibit the sharing of participant information and survey data in a non-aggregated format, as well as methods for storing and sending confidential information.

We will conclude Phase Two with a report of our findings from the literature review and interviews, and a searchable database. The report will contain an analysis of current safety practices, research needs to address their effectiveness, and current “best practices” for ensuring environmental and occupational safety when producing or using engineered nanoparticles. The report will also examine current initiatives seeking to develop more appropriate recommendations on the safe production and use of engineered nanomaterials.

VII. MANAGEMENT PLAN

Group Structure and Management

- Project Managers- Gina Gerritzen and Keith Killpack
  - Assign and direct research
  - Keep track of timeline and milestones
  - Monitor progress of team members on individual tasks
  - Schedule interviews
  - Facilitate development of interview questionnaire
- Facilitator- Maria Mircheva
  - Facilitate meetings
  - Update meeting agendas
  - Keep team morale up
- Data Manager- Keith Killpack
- Maintain shared folder on “G” drive
- Responsible for adherence with confidentiality protocol
- Act as point-of-contact with Bren Computing Staff

- Financial Manager- *Leia Huang*
  - Establish and maintain project budget
  - Track and record expenses
  - Act as point-of-contact with Bren Finance

- Webmaster- *Leia Huang*
- Design, construct and maintain project website

- Editors- *Gina Gerritzen and Joe Conti*
  - Edit documents for release outside of project team

- Survey Director- *Joe Conti*
  - Direct interview questionnaire development and performance

Geographical and Contact Responsibilities

Gina Gerritzen- Australia, Canada; USEPA/American Chemistry Council point-of-contact
Leia Huang- Asia; National Institute of Advanced Industrial Science and Technology (Japan) point-of-contact
Keith Killpack- US; NIOSH/BAuA point-of-contact
Maria Mircheva- EU; Woodrow Wilson point-of-contact

Internal Organization Chart
Meeting Structure

Meetings will be held once per week with all students and Bren advisors for 1.5 hours. Meetings will also be held at least once per week with only students for 1 hour. Meetings will be scheduled using Corporate Time (CT). Group members are therefore required to keep their CT updated to facilitate scheduling. Every member takes their own notes at each meeting.

Systems to Ensure Deadlines Are Met

The Project Managers are charged with keeping track of deadlines and group milestones and communicating important dates to the group via e-mail and Corporate Time scheduling software. At each weekly meeting, each member updates the team on their progress related to the tasks they acquired in the prior meeting. Upcoming deadlines will be announced and new tasks will be assigned. It is vital that the tasks and due dates are clearly defined.

Conflict Resolution Process

We expect that conflict will occur amongst group members at times, as the team consists of people with different backgrounds, personalities and expectations. Everyone has different motivations for being on the project, perceptions, communication skills and working habits. With this in mind, we have developed a procedure to deal with group differences:

1. Communication. Should there be an interpersonal issue, open and respectful communication between those involved should resolve the conflict efficiently.

2. Discussion. Group members are encouraged to openly discuss with the team any source of conflict that could not be resolved via Step 1. The team has agreed to effectively and non-judgmentally listen to and address any issue raised. We believe that in this way, our team can collectively alleviate conflict most of the time.

3. Decision making. Should Steps 1 and 2 not resolve the conflict at hand, all group members will at least have a better understanding of the differing opinions involved. For conflicts pertaining to logistical disagreements on, for example, what work should be done or which project parameters should be adjusted, a simple majority vote amongst the group members will suffice. For other conflicts that cannot be resolved in the team setting, persons involved will be referred to the campus Ombuds office.

Procedures for Documenting, Cataloging, and Archiving Information

Hard copies of documents and literature will be stored in a central location in our locked office in Bren Hall 3308. Electronic data and information is stored on the
shared G drive named “nanotech.” Within this shared directory, there are various folders designed to contain certain types of information (i.e. meeting agendas, reports, literature, etc.). The “Meetings” folder will be reserved for meeting agendas. Research and readings, as well as a bibliography, will be stored in the “Literature” folder. When posting new documents, moving files or changing file names on the shared drive, group members will e-mail the team in a timely manner to inform them of the change(s). Group e-mails are archived in the ‘groupnano’ e-mail list-serv when e-mails are addressed to the project email address (groupnano@bren.ucsb.edu). This e-mail address includes all project members. E-mail correspondence with “the Client” (ICON) should always carbon copy the project e-mail address to keep team members informed of such correspondence.

The project website is maintained by the Webmaster. Group members should remember to share important documents/information that need to be posted on the website with the Webmaster.

Group members should always use Corporate Time to schedule meetings and related activities. Therefore, individuals should frequently update their CT schedule. Should a room (other than BH 3308) or teleconference pod be necessary for a meeting, an e-mail will be sent to roomrequest@bren.ucsb.edu.

Interaction Guidelines (Faculty Advisor, Client)

“The Advisor” (Trish Holden and Magali Delmas) will generally play a consulting role to help the team maintain its direction, although occasionally the Advisor may intervene as “the boss” and direct the project into a new direction. The Client has indicated that s/he would like meeting summaries e-mailed to him/her by the PI on a weekly basis. The Advisor and the Client will receive deliverables in the form of a hardcopy and/or an electronic form, according to the preferences of the individual.

Overall Expectations

Expectations of Group Members
The team expects each group member to stay on task, help each other as needed, and meet team/individual deadlines. All team members are expected to make the group project a priority. Further, group members will respect and maintain a cordial relationship with one another.

Group members expect the Advisor to give guidance and feedback on the research and project deliverables. Group members also expect the Advisor to help the team maintain a “right” direction.

Expectations of Faculty Advisor
Expectations of the Advisor with regards to faculty involvement and grading criteria:
Due to the timeline of this project, the Advisor will cooperate with the group members to finish the deliverables of each phase in a timely manner. Group members will finish weekly tasks and report to the Advisor in weekly meetings. Clear and frequent communication between the Advisor and students will ensure that both parties are aware of and able to meet each others’ expectations in this regard. The Advisor may increase her level of supervision if she perceives that current research efforts of the project group are not adequate to meet research goals, scope and methodology in a timely fashion. The Advisor shall review all documents and provide constructive feedback, advice and criticism on all facets of the group project. At the conclusion of each quarter, written evaluations of each group member and of the team, as a whole, shall be provided by the Advisor.

**Expectations of Client**

The Client shall be available to assist the project members whenever deemed necessary and provide information in person and/or via phone and email. The Client will play a role in the defining of the scope of the project and provide constructive criticism and advice. It is desired that the Client provide contacts and develop relationships with stakeholders and other related parties.

**Contact Information**

**Group Members:**
Gina Gerritzen  
g Gerritzen@bren.ucsb.edu  
Keith Killpack  
rkillpack@bren.ucsb.edu  
Leia Huang  
lhuang@bren.ucsb.edu  
Maria Mircheva  
mmircheva@bren.ucsb.edu  
Joe Conti  
jconti@bren.ucsb.edu

**Faculty Advisors:**
Patricia Holden  
holden@bren.ucsb.edu  
Magali Delmas  
delmas@bren.ucsb.edu

**Client contact:**
David Johnson, ICON  
Drj@rice.edu  
Tracy Godfrey, Environmental Defense, ICON’s Working Group on Best Practices  
tgodfrey@environmentaldefense.org

**VIII. OBJECTIVES AND TIMELINE**

**Objectives**

**Phase One:** Review “best practices” development efforts for nanomaterial risk management.
1. Identify and survey any other existing “best practices” development efforts directly relevant to nanomaterial risk management occurring worldwide, including efforts to develop guidelines for working safely with engineered nanomaterials
2. Review and analyze existing “best practices” literature
3. Produce a report on findings of the literature review that includes the following elements:
   a) description of research sources (e.g., open literature, government databases, trade associations, individual company databases, etc.)
   b) best practices for research development, production, use and disposal including, but not limited to:
      • worker exposure
      • waste and by-product disposal
      • management in product distribution
      • product use
      • product end-of-life
   c) identification of current “best practices” based on government standards (either in existence or being developed) that apply to nanomaterials

Phase Two: Survey current practices for nanomaterial risk management.
   1. Develop a list of targets for interviews
   2. Construct an interview schedule
   3. Conduct interviews
   4. Summarize findings from interviews
   5. Analyze findings - analysis will include:
      a. similarities in practices based on material type or application
      b. significant differences in practices across fields or organizations
      c. likely effectiveness of evaluated practices and significant gaps in safety practices
      d. recommendation of “best practices” by material type or application
      e. costs for implementation or classification of the measures as either high capital cost (e.g., engineering controls) or low cost (e.g., training, work place behavior or standard operating procedures)
   6. Produce a report on findings of both the literature review and the interviews

Timeline

The timeline of the project is predetermined by our client. Phase One results are due early June 2006. Phase Two survey activity will take place during the summer months of 2006. The first draft of the final report is due October 2, 2006 and the final draft is due November 15, 2006. The final report will be disseminated by ICON to its subscribers and posted on its website for public use.
• Late May 2006
  Phase One research complete
• Early June 2006
  Phase One report complete
  Phase Two start
• End of August 2006
  Phase Two research complete
• October 2, 2006
  Phase Two draft report to ICON
  Phase Two database complete
• November 15, 2006
  Phase Two final report to ICON
• April 2007
  Formal presentation at Bren School

IX. STAKEHOLDERS

The final report will be made freely and publicly available on the ICON website. The stakeholders for this project include:

- The International Council on Nanotechnology
- Companies working with nanomaterials
- Government agencies
- Relevant research institutions
- Workers involved in nanomaterial manufacturing, use and/or distribution
- Consumers of nanomaterial-containing products
- The general public and environment

X. BUDGET

This project has been funded for $55,000 by ICON based on the following budget:

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<thead>
<tr>
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<th>Year 1</th>
<th>Total</th>
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<tbody>
<tr>
<td><strong>A. SENIOR PERSONNEL</strong></td>
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<tr>
<td>1. Patricia Holden, Associate Professor, Principal Investigator</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2. Barbara Herr Harthorn, Researcher, Co-Principal Investigator</td>
<td>0</td>
<td></td>
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<tr>
<td>3. Richard P. Appelbaum, Professor, Co-Principal Investigator</td>
<td>3,000</td>
<td>3,000</td>
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<tr>
<td><strong>TOTAL SENIOR PERSONNEL:</strong></td>
<td>3,000</td>
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### B. OTHER PERSONNEL

#### 4. TBN, Graduate Student Researcher Step VII

Year 1:
- 3 months summer @ $4,025/month x 50%  
  $6,038
- 6 months academic @ $4,106/month x 25%  
  $6,159

#### 5. (3) TBN, Graduate Student Assistants

Year 1:
- 40 hrs/week x 12 weeks x $15/hour x 3 students (6/15-9/15)  
  $21,600

**TOTAL OTHER PERSONNEL:**  
$33,797

### C. FRINGE BENEFITS

1. Patricia Holden, Associate Professor, Principal Investigator  
   BASE = $0  
   RATE = 17.00%  
   $0

2. Barbara Herr Harthorn, Researcher, Co-Principal Investigator  
   BASE = $0  
   RATE = 17.00%  
   $0

3. Richard P. Appelbaum, Professor, Co-Principal Investigator  
   BASE = $3,000  
   RATE = 12.70%  
   $381

4. TBN, Graduate Student Researcher Step VII

Year 1:
- BASE = $6,038  
  RATE = 3.00%  
  $181
- BASE = $6,159  
  RATE = 1.30%  
  $80

  Graduate Student Health Insurance* (2 quarters)  
  FALL/SPRING  
  $1,365

  Partial tuition/fee remission* (2 quarters)  
  FALL/SPRING  
  $6,072

5. (3) TBN, Graduate Student Assistants

Year 1:
- BASE = $21,600  
  RATE = 3.50%  
  $756

**TOTAL FRINGE BENEFITS:**  
$8,835

**TOTAL SALARY & FRINGE BENEFITS:**  
$45,632

### D. TRAVEL

1. RT Airfare for 4 west coast trips @ $300/ea trip  
   $1,200

2. Per diem @ $150/day x 3 days/trip x 4 trips  
   $1,800

3. RT Airfare for 3 east coast trips @ $600/ea trip  
   $1,800

4. Per diem @ $150/day x 4 days/trip x 3 trips  
   $1,800

**TOTAL TRAVEL COSTS:**  
$6,600

### E. OTHER DIRECT COSTS

1. Telephone tolls  
   $500

2. Photocopying reports and other information  
   $200

**TOTAL OTHER COSTS:**  
$700

### F. TOTAL PROJECT DIRECT COSTS

$52,932

### G. INDIRECT COSTS

| HEALTH |
| INSURANCE |
| (1,365) |

**TOTAL INDIRECT COSTS:**  
$52,932

**TOTAL PROJECT DIRECT & INDIRECT COSTS:**  
$52,932
<table>
<thead>
<tr>
<th>Description</th>
<th>Amount 1</th>
<th>Amount 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUTION/FEEES</td>
<td>(6,072)</td>
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<tr>
<td>MODIFIED TOTAL DIRECT COSTS (MTDC):</td>
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<td>TOTAL INDIRECT COSTS*** MTDC x 47%</td>
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<td>J. TOTAL PROJECT DIRECT &amp; INDIRECT COSTS</td>
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<td>TOTAL REQUESTED YEAR 1:</td>
<td>74,314</td>
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</table>

* Provided to all Graduate Student Researchers and Teaching Assistants employed at 25% or more.

***This is the DHHS negotiated, predetermined On-Campus rate for Research Projects covering the period July 1, 2004 through June 30, 2005. The rate thereafter is provisional.