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ARTICLE

Big Things In Small Packages: Evaluating the City of Berkeley's Nanotechnology Ordinance Effectiveness as a Model of Targeted Transparency

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I. INTRODUCTION

Nanotechnology continues to advance at a rapid pace, appearing in a growing number of consumer products and comprising an increasingly significant portion of the United States' economy. But for all their futuristic promise, some forms of nanotechnology pose an environmental health threat, and have been linked to lung cancer. Despite the real risk of harm, no federal agency has adopted nanotechnology regulations to protect human health and the environment. A diverse group of NGOs, academics, and community activists support expeditious regulation of the industry. Industry insiders are also concerned by the slow progress of government oversight. They fear that by not addressing environmental, health, and safety concerns, the public trust will erode to the point that the economic and social benefits of nanotechnology are occluded.

The City of Berkeley's Engineered Nanoparticle Disclosure Ordinance (BENDO) is the first and only city policy regulating

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nanotechnology in the nation.[1] The BENDO follows a transparency model requiring nanoparticle manufacturers and handlers to disclose toxicological, environmental, and safety information to the City's Toxics Management Division.[2] If expanded to the state or national level, this model could be used to create a uniform nanotechnology regulatory policy.[3]

The purpose of this article is threefold. First, a practical ideal model of a nanotechnology disclosure policy is developed based on relevant literature. Second, the BENDO is assessed using the practical ideal type characteristics. Finally, recommendations to improve the BENDO are presented based on the assessment.

II. BACKGROUND

Nanotechnology is the creation of structures of the size of 100 nanometers or smaller in any one dimension.[4] For comparison, a hair is approximately 80,000 nanometers wide while a typical smallpox virus particle is roughly 300 nanometers in length.[5] Materials reduced to the nanoscale can display novel properties that are not present in the macroscale.[6] For example, the same chemical composition of silicon can emit different colors of light depending upon its size.[7] Nanotechnology's novel properties offer many environmental and commercial benefits including:

1. *See* CITY OF BERKELEY, CAL., MUN. CODE §§ 15.12.010–15.12.170 (2008), *available at* http://codepublishing.com/ca/berkeley/html/pdfs/Berkeley15.pdf.

2. *Id.*

3. Gary Marchant, Lincoln Professor of Emerging Tech., Law & Ethics, Ctr. for the Study of Law, Sci. & Tech., Sandra Day O'Connor Coll. of Law, Speech at Arizona State University: Emerging Technologies and the Environment (Sept. 10, 2007).

4. Nat'l Nanotech. Initiative, *What's So Special about the Nanoscale?*, NANO.GOV, http://www.nano.gov/nanotech-101/special (last visited Mar. 27, 2013).

5. Nat'l Nanotech. Initiative, *Size of the Nanoscale*, NANO.GOV, http://www.nano.gov/nanotech-101/what/nano-size (last visited Mar. 27, 2013).

6. Nat'l Nanotech. Initiative, *supra* note 4.

7. Karlsruhe Inst. of Tech., *Light From Silicon Nanocrystal LEDs*, PHYS.ORG (Feb. 18, 2013), http://phys.org/news/2013-02-silicon-nanocrystal.html.

remediation of pollutants, solar energy technology, and the ability to make stronger, lighter, and more fuel efficient vehicles.[8]

However, the benefits of nanotechnology do not come without risk. Recent research shows that carbon nanotubes share carcinogenic properties with asbestos.[9] Fullerenes, tiny structures of carbon that resemble soccer balls, have been shown to cause brain damage in aquatic animals.[10] And quantum dots, that hold the promise of targeted delivery of medicine, also pose toxicological risks to human and environmental health.[11] Novel properties also mean that parent materials cannot be relied upon to dictate the toxicological data of their nano-engineered counterparts.[12] For example, while carbon nanotubes may increase the risk of mesothelioma, non-engineered carbon particulates of similar size do not pose a similar risk.[13]

The White House describes nanotechnology as leading to the "next industrial revolution."[14] According to Lux Research, by the year 2014, 15% of all commercial products world-wide will incorporate nanotechnology with a combined economic value of over one trillion dollars.[15] Unfortunately, research into the environmental and health effects of nanotechnology has not kept up with the growth of the commercial industry. In 2005, through the National Nanotechnology Initiative, the U.S. Government

8. Nat'l Nanotech. Initiative, *supra* note 4.

9. Craig A. Poland et al., *Carbon Nanotubes Introduced into the Abdominal Cavity of Mice Show Asbestos-like Pathogenicity in a Pilot Study*, 3 NATURE NANOTECH. 423, 423 (2008).

10. Eva Oberdörster, *Manufactured Nanomaterials (Fullerenes, C_{60}) Induce Oxidative Stress in the Brain of Juvenile Largemouth Bass*, 112 ENVTL. HEALTH PERSP. 1058, 1058 (2004).

11. Ron Hardman, *A Toxicologic Review of Quantum Dots: Toxicity Depends on Physicochemical and Environmental Factors* 114 ENVTL. HEALTH PERSP. 165, 171 (2006).

12. Morteza Mahmoudi et al., *Assessing the in vitro and in vivo toxicity of superparamagnetic iron oxide nanoparticles*, 112 CHEM. REVS. 2323 (2011).

13. Poland et al., *supra* note 9, at 425.

14. NAT'L SCI. & TECH. COUNCIL, NATIONAL NANOTECHNOLOGY INITIATIVE—LEADING TO THE NEXT INDUSTRIAL REVOLUTION, INTERAGENCY 46 (2011), *available at* http://www.ostp.gov/NSTC/html/iwgn/iwgn.fy01budsuppl/nni.pdf.

15. LUX RES., STATEMENT OF FINDINGS: SIZING NANOTECHNOLOGY'S VALUE CHAIN 1 (2004).

invested over one billion dollars in nanotechnology research with less than eleven million earmarked for risk related research.[16]

The dearth of toxicological information and lack of standard risk assessment protocols make it difficult to determine the adverse effects of engineered nano-sized materials on biologic systems. The large gaps in knowledge may be slowing down the regulatory process.[17] As of 2006, an estimated 700 types of nanomaterials are being manufactured at about 800 facilities in the United States; yet, no agency has developed safety rules specific to nanomaterials.[18] J. Clarence Davies, co-creator of the Environmental Protection Agency (EPA), has called for a new federal agency to conduct research and perform regulatory oversight of the nano-industry.[19] He argues that the current federal regulatory agencies already "suffer from under-funding and bureaucratic ossification. . . ."[20] "[Agencies] will require more than just increased funding and minor rule changes to deal adequately with the potential adverse effects of the new technologies . . . and many of these changes will take a decade or more to accomplish. . . ."[21]

At the same time, local and state agencies are taking action now to fill in the gaps of nano oversight, as illustrated by the Woodrow Wilson Institute's Project on Emerging Nanotechnology (PEN). PEN's Suellen Keiner writes that this bottom-up approach could serve as a "laboratory for democracy" by providing the federal government with a proof of concept for regulatory oversight.[22] Local disclosure regulations could also provide data

16. ANDREW D. MAYNARD, WOODROW WILSON INT'L CTR. FOR SCHOLARS, A RESEARCH STRATEGY FOR ADDRESSING RISK 3 (2006), *available at* http://www.nanotechproject.org/ file_download/files/PEN3_Risk.pdf.

17. J. CLARENCE DAVIES, OVERSIGHT OF NEXT GENERATION NANOTECHNOLOGY 13 (2008).

18. Christine M. Pense & Stephen H. Cutcliffe, *Risky Talk: Framing the Analysis of the Social Implications of Nanotechnology*, 27 BULL. SCI., TECH. & SOC'Y 349, 354 (2007).

19. DAVIES, *supra* note 17, at 3 (calling for "a new federal Department of Environmental and Consumer Protection").

20. *Id.*

21. *Id.*

22. *See generally* SUELLEN KEINER, ROOM AT THE BOTTOM? POTENTIAL STATE AND LOCAL STRATEGIES FOR MANAGING THE RISKS AND BENEFITS OF NANOTECHNOLOGY (2008).

for environmental and safety standards as well as thresholds for nanoparticle toxicity exposure. Keiner identifies California as being one of five states most able to launch initiatives for overseeing safe and responsible development of nanotechnology.[23] The Toxics Management Division (TMD) is the regulatory agency within the City of Berkeley that is responsible for implementation of the BENDO.[24]

The BENDO, enacted in 2006, is the first law in the nation that addresses environmental health and safety issues related to nanotechnology.[25] Based on its authority under Chapter 6.95 of the California Health and Safety Code,[26] the Berkeley City Council amended its municipal code to require facilities that manufacture or use engineered nanoparticles to disclose toxicological as well as pollution and exposure prevention information.[27]

Any facility that manufactures or handles nanomaterials is subject to the regulatory disclosure requirements.[28] Retail businesses that sell consumer goods that contain nanomaterials are exempt from the regulatory requirement.[29] Examples of consumers goods that may contain nanomaterials are ultra-light bicycle frames, titanium dioxide based sun screen, and odor eating socks that use nano-sized silver particles as anti-microbial agents.[30] At the time the BENDO was enacted, there were only four facilities operating in Berkeley that manufactured nanoparticles.[31] Two of the facilities, Bayer Healthcare Pharmaceuticals and Lawrence Berkeley National Laboratories,

23. *Id.* at 8.

24. *Id.* at 21.

25. Javiera Barandiaran, The Berkeley City Ordinance on Nanotechnology: Shortcomings, Improvements, and Implications for Risk Governance 4 (Mar. 11, 2007) (unpublished manuscript), *available at* http://step.berkeley.edu/White_Paper/Barandiaran.pdf.

26. CAL. HEALTH & SAFETY CODE § 6.95 (West 2010).

27. KEINER, *supra* note 22, at 19.

28. Interview with Nabil Al-Hadithy, Sec'y, City of Berkeley Cmty. Envtl. Advisory Comm'n, in Berkeley, Cal. (June 4, 2010).

29. *Id.*

30. *Id.*

31. *Id.*

are among the largest employers in the City, with 1,500 and 4,000 workers respectively.[32]

The City does not provide forms or a template for businesses to fill out, nor does it specify the format in which information must be submitted. The majority of submissions reviewed employ a narrative, business letter format. Reporting requirements of the BENDO are categorized as follows:

- *Characterization*: particle dimensions, mass, phase[33]
- *Toxicology*: exposure pathways, mutagenicity, bioaccumulation[34]
- *Occupational Safety*: personal protective equipment, engineering controls, spill mitigation[35]

The BENDO's disclosure framework is unique—distinguished from more traditional, command and control regulation—in several ways, as exemplified by the criterion set forth by Fung and O'Rourke.[36] First, in contrast to setting and enforcing standards on nanotechnology producers, the BENDO primarily aims to provide private citizens, interest groups, and firms with relevant information related to production volume, life cycle, and environmental health and safety.[37] Second, environmental requirements such as toxicological thresholds, exposure monitoring, and disposal analysis, are not initially determined by risk assessment and toxicological metrics; instead, the desired outcome of the BENDO is for firms to adopt environmental safety measures in response to a dynamic range of public pressures.[38] Finally, rather than the creation of agency

32. *Id.*

33. CITY OF BERKELEY, CAL. TOXICS MGMT. DIV., MANUFACTURED NANOSCALE MATERIALS HEALTH & SAFETY DISCLOSURE GUIDELINES 2 (2011), *available at* http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Toxics/Nanoscale%20Reporting%20Guidelines%202011.pdf.

34. *Id.*

35. *Id.*

36. Archon Fung & Dara O'Rourke, *Reinventing Environmental Regulation from the Grassroots Up: Explaining and Expanding the Success of the Toxics Release Inventory*, 25 ENVTL. MGMT. 115 (1998).

37. *Id.*

38. *Id.*

standards or government sanctions, public pressure focuses on those who do not conform to the acceptable standard to induce them to adopt more effective environmental practices.[39]

Disclosure laws, like those put forth in the BENDO, have notable benefits compared to coercive, command and control regulations. For instance, they are relatively inexpensive to draft and implement.[40] Furthermore, they can serve as vehicles for gathering data that can in turn inform the creation of environmental safety standards.[41] Finally, the laws can simultaneously support the improvement of environmental quality and the democratic belief in the public's right to know about environmental risks associated with the products and services they consume.[42] This last point especially illustrates that disclosure laws are more politically feasible than coercive regulations. However, there are also shortcomings to taking the disclosure law approach. In the absence of effective planning, strategic execution, and sound politics, transparency's effectiveness can be compromised.[43] In addition, it can be challenging to measure the success or failure of disclosure laws.[44]

Given the explosive economic growth projected for nanomaterials, manufacturers of nanomaterials have an economic incentive to protect their intellectual property related to their research and development while satisfying the information requirements of the BENDO. The BENDO incorporates the trade secret protections mandated by the Hazardous Materials Reporting section of the California Health and Safety Code.[45]

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39. *Id.*

40. Hua Wang, *Environmental Information Disclosure*, *in* GUIDANCE NOTES ON TOOLS FOR POLLUTION MANAGEMENT § 2.1.9, 5 (World Bank Grp. 2008).

41. *Id.*

42. David Weil, Professor, Bos. Univ. Sch. of Mgmt., Presentation at the Federal Trade Commission Conference on Consumer Information and the Mortgage Market: Promise and Pitfalls of Transparency: Insights for the Mortgage Market Crisis (May 29, 2008).

43. *See generally* RICARDO CRUZ PRIETO, TRANSATLANTIC CONFERENCE ON TRANSPARENCY RESEARCH, ON THE DISADVANTAGES OF TRANSPARENCY FOR GOVERNMENT: REFLECTIONS ON SOME ARGUMENTS AGAINST TRANSPARENCY AS A DEMOCRATIC REFORM STRATEGY (2012).

44. Fung & O'Rourke, *supra* note 36, at 123.

45. CAL. HEALTH & SAFETY CODE §§ 25251–25257.1 (West 2012).

Information determined to be trade secrets is protected from public disclosure and required to be kept under lock and key.[46]

III. ELEMENTS OF SUCCESSFUL TARGETED TRANSPARENCY

This Section reviews the research of Archon Fung, Mary Graham, and David Weil on targeted transparency in order to construct a framework for evaluating the design and implementation of the BENDO. This Section discusses the definition of targeted transparency, along with the benefits and risks of implementing a targeted transparency program. Next, practical ideal type elements that are common to successful targeted transparency programs are identified. This Section concludes with an operationalization table of the conceptual framework that will be used to assess the BENDO.

A. Targeted Transparency: An Emerging Regulatory Model

Government transparency is essential to an informed citizenry and democracy. The Freedom of Information Act (FOIA)[47] creates a broad statute for insuring openness in government. Recent efforts have expanded the concept of sun lighting information and applied it to achieving more specific regulatory goals.[48] The mandate to disclose information is no longer limited to government but extends to corporations and other organizations.[49] The result of this evolution is what Archon Fung, Mary Graham, and David Weil call "targeted transparency"—the use of publicly required disclosure of information in a standardized format to achieve a clear public

46. *Id.*

47. 5 U.S.C. § 552 (2012).

48. David Hess, *Social Reporting and New Governance Regulation: The Prospects of Achieving Corporate Accountability Through Transparency*, 17 BUS. L.Q. 453, 454 (2007), *available at* http://webuser.bus.umich.edu/dwhess/Hess_BEQ%202007_Social%20Reporting%20and%20New%20Gov%20Reg.pdf.

49. *Id.*

purpose.[50] Unlike the calls for transparency in *all* aspects of government, targeted transparency is grounded in the very selective disclosure of information from specific actors that are not necessarily limited to government.

Targeted transparency is gaining popularity with policy makers for many reasons. For one, it is cheaper and—politically—less controversial than standards-based regulatory requirements. It leverages the will of the citizenry rather than the government to achieve its objectives, thus responding to the growing criticism of the government's ability to solve problems on its own with expensive funding or traditional regulation. Finally, targeted transparency may be more easily applied to problems that cannot easily be defined, vary by locale, or are characterized by wide differences in concern amongst citizenry.[51]

Since 1996, the federal government has adopted over 150 targeted transparency policies to address such diverse concerns as SUV rollovers, public school performance, financial integrity of banks, worker safety, and environmental pollution.[52] The 1984 chemical release in Bhopal, India that killed thousands of people instigated U.S. Congress to pass the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA).[53] Perhaps the most well-known of all of the environment targeted transparency laws, EPCRA supports emergency planning for state and local governments and provides citizenry and local governments with information concerning chemical hazards present in their community.[54] The BENDO applies many of the same policy goals of EPCRA to nanoparticles.

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50. ARCHON FUNG, MARY GRAHAM & DAVID WEIL, FULL DISCLOSURE: THE PERILS AND PROMISE OF TRANSPARENCY (2007) [hereinafter FUNG ET AL.]; *see also* David Weil, *Targeted Transparency*, *in* ADVANCING EXCELLENCE AND PUBLIC TRUST IN GOVERNMENT 77, 77 (Cal Clark & Don-Terry Veal eds., 2011).

51. *See generally* FUNG ET AL., *supra* note 50.

52. *Id*. at 20.

53. 42 U.S.C. §§ 11001–11050 (2012); LINDA-JO SCHIEROW, CONG. RESEARCH SERV., RL 32683, THE EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT (EPCRA): A SUMMARY 1 (2012), *available at* http://www.fas.org/sgp/crs/misc/RL32683.pdf.

54. 42 U.S.C. §§ 11001–11050.

Targeted transparency considers two types of stakeholders: information disclosers and information users.[55] Information disclosers are those required to provide information in the specific format that the policy dictates, and who policymakers target to effect behavioral change.[56] Information users draw upon the information that they find relevant in an effort to inform their choices.[57] The targeted transparency policy has an effect when the information enters the decision making process of users and influences their decisions.[58] This in turn affects disclosure behavior in what Fung, Graham, and Weil term the "Action Cycle."[59]

In the case of the BENDO, there is a diverse group of both information disclosers and information users. Since nanotechnology spans different industries, the BENDO disclosers include federal research laboratories, drug manufacturers, manufacturers of consumer cosmetics, and higher education institutions.[60] Information users are also diverse, with different incentives for using information. They include: emergency responders, toxic reduction advocacy groups, property speculators, neighborhood groups, and—because of the uniqueness of the ordinance itself—other policy makers, and policy researches.[61] Thus, a diversity of interests is represented by each user. The stakeholders in the City of Berkeley are largely representative of the state of California as a whole and perhaps the nation. This is important when considering the feasibility of using the BENDO as a model for a larger audience.

55. David Weil et al., *The Effectiveness of Regulatory Disclosure Policies*, 25 J. POL'Y ANALYSIS & MGMT. 155, 156 (2005).

56. *Id.* at 157.

57. *Id.*

58. *Id.* at 158.

59. Archon Fung et al., *The Political Economy of Transparency: What Makes Disclosure Policies Effective?* 4 (Ash Inst. for Democratic Governance & Innovation, Working Paper No. 12, 2004), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=766287.

60. Interview with Nabil Al-Hadithy, *supra* note 28.

61. *Id.*

B. Evaluating the BENDO: A Conceptual Framework

Based on a review of the relevant literature, the conceptual framework used to evaluate the effectiveness of the BENDO consists of the following categories:

- Extent to which policy fills an information gap[62]
- Accuracy of information[63]
- Cost and resources[64]
- Enforcement[65]
- User embeddedness[66]
- Discloser embeddedness[67]
- Feedback and evaluation mechanism[68]
- Involvement of user groups[69]
- Extent to which existing regulatory programs are leveraged[70]

All elements of the framework identified above are taken from the literature. The remainder of this section draws upon this literature to provide an examination and justification of the elements of a successful nanoparticle transparency policy.

C. Extent to Which Policy Fills an Information Gap

Before we can begin to evaluate the effectiveness of the BENDO, we must first establish whether the goals of the policy problem it seeks to address are compatible with targeted transparency. Targeted transparency assumes that an information gap is somehow contributing to the regulatory

62. FUNG ET AL., *supra* note 50, at 174.
63. *Id.* at 178.
64. Edward P. Weber, *Successful Collaboration: Negotiating Effective Regulations*, 40 ENV'T: SCI. & POL'Y FOR SUSTAINABLE DEV. 11, 12 (1998).
65. FUNG ET AL., *supra* note 50, at 39.
66. Fung et al., *supra* note 59, at 10-13.
67. *Id.* at 13-15.
68. *Id.* at 20.
69. *Id.* at 7-9.
70. Weber, *supra* note 64, at 13.

problem. In order for targeted transparency to be effective, the nature of the information gap should be known.[71] One way to determine the nature of the information gap and its relation to risk is to perform a risk assessment.[72] Thus, policymakers should ask how bridging the information gap reduces risk.

D. Information Accuracy

For information to be of value it must adhere to a standard of accuracy.[73] There are four junctures where there are opportunities for data to become inaccurate. The first is initial data entry.[74] This can occur because of typos, poor data entry forms, or poor training of the data-entry staff.[75] The second source of data inaccuracy, called "data movement," is a result of mistakes made when extracting or loading data into a secondary data source.[76] Many data entry errors occur when the initial data is entered on paper and then entered manually into a secondary computer database.[77] The third source of inaccuracy is when data reports, spreadsheets, query results, or summaries are generated from the database.[78] If the person extracting the information does not understand the data map, fields, and data dictionary then inaccurate information can be drawn from accurate data.[79] Data decay occurs when data is not updated; data must be reviewed to ensure that it is accurate over time.[80]

E. Costs and Resources

For transparency policies to be sustainable they need to have a steady funding source, seeing as regulations that are underfunded tend to have higher rates of noncompliance than

71. FUNG ET AL., *supra* note 50, at 174.
72. *Id.*
73. *Id.* at 109.
74. JACK E. OLSON, DATA QUALITY: THE ACCURACY DIMENSION 34 (2002).
75. *Id.*
76. *Id.* at 52-62.
77. *Id.*
78. *Id. at* 50.
79. *Id.*
80. OLSON, *supra* note 74, at 50.

funded mandates.[81] However, because estimating the costs of these policies can be difficult, fee schedules should be structured in a way that they can adapt to changes within the industry.[82]

F. Enforcement

Voluntary disclosure is only as good as the commitment of the disclosers because it requires no enforcement. On the other hand, effective targeted transparency requires a robust enforcement program and the ability to levy sanctions against noncompliant parties.[83] Enforcement actions should be publicized for maximum exposure and to act as a deterrent to noncompliant actors. Enforcement that collects monetary penalties can also be used as a funding source to reduce costs.

G. User Embeddedness

Even if we assume that targeted transparency creates a new body of publicly accessible information, *how* the users make decisions with that information depends on a number of factors. When new information becomes part of a user's decision making routing it becomes what Weil et al. calls "embedded."[84] According to Weil et al., the following three factors are key as to whether a transparency policy becomes embedded in user's decision making routines:

- The information's perceived value in achieving user's goals[85]
- The information's compatibility with user's decision making routines[86]
- The information's comprehensibility[87]

81. James R. St. George, *Unfunded Mandates: Balancing State and National Needs*, 13 BROOKINGS REV. 12, 12-15 (1995).
82. Weil et al., *supra* note 55, at 156.
83. FUNG ET AL., *supra* note 50, at 45.
84. Weil et al., *supra* note 55, at 155-56.
85. *Id.* at 159-62.
86. *Id.*
87. *Id.*

How users value information depends on a number of dynamic factors. Each user may determine the value of information differently and for different choices.[88] For example, a new home buyer may use information based on the toxic release inventory to determine if there are polluters in his prospective neighborhood. A local government agency may use the same information to amend zoning ordinances. Someone who is not concerned about the effects of airborne contaminants on his or her health may not value the information at all.

Similarly, additional information may not help users for whom there are limited choices available.[89] An out-of-work factory worker may not have the luxury of changing jobs even if he is concerned about the level of chemical hazards present in his work place. Affordable housing may only exist in areas where pollution emissions are high thus being the primary limiting factor of low-income home buyers. The value of the information to these users would be low since it would not have much effect on their decision making process.

In addition to information needing to be of value to users, it must also be compatible with the information user's decision making routines.[90] According to Fung, Graham, and Weil, compatibility consists of two components: format, and time and place of availability.[91] Format can be used to mitigate complexity into a simpler system such as grading from A-F or a star rating system.[92] Time and place of availability refers to where and when the information is accessible to users.[93] The restaurant grading system of Los Angeles County serves as a prime example of having an easy to understand format and—by posting the grade on the restaurant window—the temporal and spatial availability of the system.[94]

Value and compatibility are not always enough to ensure that information becomes embedded in user decisions. If

88. *Id.*
89. *Id.* at 173.
90. Weil et al., *supra* note 55, at 161.
91. *Id.*
92. *Id.*
93. *Id.*
94. *Id.* at 169.

information is not comprehensible users may not understand how to use it to their benefit.[95] User groups, face a difficult balancing act between providing information that is too technical or too simplistic, since information that is too technical can exclude users who might otherwise benefit from the information and information that is too simplistic may leave out pertinent information.[96] For instance, the Material Safety Data Sheets (MSDS) that the Occupational Safety and Health Administration (OSHA) requires be made available to workers are filled with technical jargon that the majority of workers do not understand.[97] While OSHA requires that employers provide MSDSs to their employees, they do not require that their employees *understand* the MSDSs.[98] In addition, OSHA does not require that chemical manufactures publish MSDSs with user comprehensibility in mind.[99]

H. Disclosure Embeddedness

Disclosers also have to be embedded in order for transparency policies to be most effective. Even if transparency policies successfully change user decisions, for long-term sustainability, disclosers' behavior must also be altered.[100] Thus, the results of user decisions need to be communicated to the disclosers so that the users have the potential to change the behavior of the disclosers, in line with policy goals.[101] In the case of the BENDO, it means that producers of nanotechnology—the disclosers—will take steps to reduce risks as a result of user decision making.

95. FUNG ET AL., *supra* note 50, at 59.
96. *Id.* at 59-60.
97. Weil et al., *supra* note 55, at 172.
98. Charles C. Phillips et al., *The Efficacy of Material Safety Data Sheets and Worker Acceptability*, 30 J. SAFETY RES. 113, 113-14 (1999).
99. *Id.*
100. Weil et al., *supra* note 55, at 161.
101. *Id.*

I. Feedback and Evaluation Mechanism

In the current information age new metrics, benchmarks, and analysis are being produced at an exponential growing rate. Because transparency policies depend on the quality of the information they collect, they are prone to becoming outdated unless they are consistently reviewed, evaluated, and updated.[102] Therefore, effective policies tend to create requirements for frequent evaluation, feedback, and policy revision.[103] This serves to not only promote adaptation to changing circumstances but also foster user and discloser participation by giving them a vested interest in the policy's future.[104]

J. Involvement of User Groups

Transparency policies are strengthened when user groups take an active interest in supporting them. By publicizing, translating, and promoting information exchange, user groups can compensate for weaknesses that may be inherent in the policy itself.[105] The technical complexities of the MSDSs discussed earlier are often mitigated by labor unions that translate and disseminate hazardous chemical exposure information to their members.[106] Though the Federal Toxic Release Inventory is difficult for lay people to understand, the data is routinely summarized and publicized by news media outlets and bloggers.[107] Policy makers should be aware of the positive role of user groups and take steps to promote their involvement.

102. FUNG ET AL., *supra* note 50, at 176-77.
103. *Id.* at 179.
104. *Id.*
105. *Id.* at 177.
106. Phillips et al., *supra* note 98, at 113-14.
107. FUNG ET AL., *supra* note 50, at 162.

K. Extent to which Existing Regulatory Programs are Leveraged

Whenever possible, transparency policies should leverage existing programs to achieve policy goals.[108] Existing programs economize staffing resources, fill in deficiencies such as enforcement and sanctions, and keep costs down. The restaurant hygiene grading system of Los Angeles County would not work without a health inspection system, nor should it be thought of as a replacement for that system.[109] Because targeted transparency is a complement and not a replacement for other forms of public intervention, it is important that they work in tandem with other government policies.[110]

IV. METHODOLOGY

This research draws on document analysis and structured interviews, using as a case study the BENDO regulatory process. A discussion of the documents and interviews used in the analysis follows. The weaknesses of the study are discussed as well.

The case study research method was used to assess the BENDO against a model program developed from reviewing the literature. Robert K. Yin defines case study research as a "research strategy . . . used in many situations to contribute to our knowledge of individual, group, organizational, social, political, and related phenomena."[111] Case study was the preferred method of comparing the BENDO to an ideal model. According to Earl Babbie, triangulation involves "[t]he use of several different research methods to test the same finding. . . ."[112] Triangulation is important because every method of research has strengths and weaknesses, which may have an

108. Telephone Interview with Archon Fung, Professor of Pub. Policy, John F. Kennedy Sch. of Gov't, Harvard Univ. (Aug. 13, 2008).

109. Weil et al., *supra* note 55, at 169-70.

110. *Id.* at 169.

111. ROBERT K. YIN, CASE STUDY RESEARCH: DESIGN AND METHODS 1 (3d ed. 2011).

112. EARL R. BABBIE, THE PRACTICE OF SOCIAL RESEARCH 118 (12th ed. 2010).

effect on the findings.[113] Yin concurs that "[a]ny finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information. . . ."[114] In fact, triangulation is one of the strengths of case study research.

Several data collection mechanisms were used in this study. First, focused interviews of users and disclosers elicited data on the BENDO. Second, document analysis was conducted of the Berkeley Toxics Management's policies and procedure manual, Community Environmental Advisory Commission (CEAC), and Berkeley City Council meeting minutes. Finally, data from agency reports to California EPA (CUPA to state reports), agency self-audits, BENDO disclosure submissions, and Berkeley facility hazardous materials disclosures were used to supplement the focused interviews.

Focused interviews both clarify information from the literature review and provide perspective on the roles of each actor. Many interview questions pertained to the practical ideal elements of an effective transparency disclosure policy. As established earlier, the ideal elements of a transparency disclosure policy come from the research of Archon Fung, Mary Graham, and David Weil of the Transparency Policy Project. Other elements were derived from the Project on Emerging Nanotechnologies (PEN).

A. Operationalization

Operationalizing links the practical ideal type categories to the data collection methods. Table 1 indicates how the conceptual framework is linked to these data collection methods: document analysis, archival data, and focused interviews. For example, the interview questions are constructed using the concepts found within the categories.[115]

113. *Id.*

114. ROBERT K. YIN, CASE STUDY RESEARCH: DESIGN AND METHODS 92 (2d ed. 1994).

115. For focused interview instruments, see *infra* Appendix A and Appendix B.

Table 1: Operationalizing the Conceptual Framework

Element	Focused Interview Question	Document Analysis	Archival Data
Extent to which policy fills an information gap A bridgeable information gap contributes to public risk Nature of information gap is known Bridging the information gap reduces risk	A7, A8	CEAC Minutes	
Accuracy of information	A35, A36	BENDO Regulatory Guidelines	
Cost and resources Cost is not prohibitive Agency has adequate resources Agency minimizes economic disincentives to disclosers	A20, A21, B6 A20, A21 A30, B8		CUPA to State Reports
Enforcement	A18, A19	TMD Policies and Procedures	CUPA to State Reports, Self-Audit
User Embeddedness The information's perceived value in achieving user goals The information's compatibility with user decision making routines The information's comprehensibility	A6, A11-A16, A23, A24, A26	CEAC Minutes City Council Minutes	Self-Audit BENDO Submissions CUPA to State Reports
Discloser	A8, A38, B3,		CUPA to

Embeddedness Impact of user decisions on discloser goals Ability to discern changes in user behavior Information disclosers can reduce risks	B8		State Reports, Self-Audit
Evaluation Mechanism There is an evaluation process of the policy Results of evaluation are incorporated into policy	A34	TMD Policies and Procedures	
Results strengthen user groups	A33		
Policy leverages existing regulatory programs	A3, A17	CEAC Minutes	BENDO disclosure submittals
Communication between regulators, users, and disclosers is practical	A23, B5		CUPA to State Reports, Self Audit

V. RESULTS AND RECOMMENDATIONS

Through document analysis and focused interviews, this assessment reveals which elements of the practical ideal transparency policy model the BENDO is currently embracing, and which elements need to be implemented or improved upon.

A. Extent to Which Policy Fills an Information Gap

The City of Berkeley created the BENDO in direct response to the dearth of environmental health and safety information on engineered nanoparticles, a lack that was deemed as a risk to emergency responders and city planning decision makers. The City conducted a comprehensive review of literature to evaluate this information gap and to determine the extent of the risk

posed.[116] Thus, the BENDO was implemented to fill this information gap and reduce the risks associate with the information gap. Still, a weakness of the BENDO is that it only requires facilities to submit information that is known. The BENDO regulatory guidelines suggest that facilities take a precautionary approach in regards to management of nanoengineered particles where health and safety information is not known.[117] However, it does not require facilities to take specific action to conduct research to fill these information gaps.[118]

To further strengthen the BENDO, TMD should incorporate an ongoing assessment of how the risk is being mitigated by the information that the BENDO provides.

Table 2: Extent to Which Policy Fills an Information Gap

Ideal Type Category	Interview	Document Analysis	Summary
Nature of information gap known	Yes	Yes	City met with subject matter experts and conducted a literature review to determine nature of information gap and risk.
Goals of policy problem consistent with targeted transparency.	Yes	Yes	Purpose of the BENDO is to require disclosure of information.
Recommendation: TMD should incorporate a regular assessment of how the risk is being mitigated by the BENDO.			

116. Interview with Nabil Al-Hadithy, Sec'y, City of Berkeley Cmty. Envtl. Advisory Comm'n, in Berkeley, Cal. (Oct. 15, 2010).
117. *Id.*
118. *Id.*

B. Information Accuracy

BENDO submittals from facilities are stored in paper form in the TMD offices. There is no translation of data from paper to electronic form. TMD has not yet compiled the data in the submittals or created any reports that draw from the data.[119]

Although TMD reviews the BENDO submittal for completeness, it does not ensure that the data is accurate.[120] Part of the reason is that TMD staff do not have the technical expertise to verify the novel toxicological data.[121] The other reason is that requiring facilities to report data significantly drains TMD's resources.[122] As the program matures, resources should be directed towards ensuring information accuracy at the facility level.

Table 3: Information Accuracy			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Source Data	No	N/A	TMD does not insure data accuracy at the facility level.
Data Movement	N/A	N/A	TMD does not move data to a secondary source.
Data Reporting	N/A	N/A	TMD does not create reports with data.
Recommendation: BENDO should adopt a procedure for auditing facility submittals for information accuracy.			

119. *Id.*
120. *Id.*
121. *Id.*
122. Interview with Nabil Al-Hadithy, *supra* note 116.

C. Cost and Resources

The BENDO is funded directly from facilities that engineer or handle engineered nanoparticles. These fees are applied when the facility submits a disclosure document. TMD staff bills the facility $150 an hour to review the submittal.[123]

TMD has not recovered the money it invested in staff resources into implementation of the BENDO. According to TMD financial records, approximately 400 billable hours were dedicated to the process of implementation.[124] The City's general fund paid for this effort. TMD records also indicate that there is no money budgeted to support the BENDO beyond the hourly charge for BENDO data entry and administrative processes.[125] Furthermore, TMD's Fee Schedule is approved by city council on a biannual basis. Changes to the Fee Schedule can be made if they are approved by the City.[126]

Bayer is one of the largest employers in Berkeley and the largest company that produces nanoparticles.[127] In regards to discloser costs, Bayer's costs have been minimal compared to the resources they spent on maintaining compliance with other regulatory programs.[128] Mr. Bowman stated that approximately five hours of staff time was used creating the BENDO submittal.[129]

Seeing as the BENDO needs a stable funding source to be successful into the future, TMD should perform a cost analysis to determine how sustainable the current funding mechanism is and whether it is sufficient for cost recovery.

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123. CITY OF BERKELEY, CAL. TOXICS MGMT. DIV., CHAPTER D – CERTIFIED UNIFORM AGENCY: FEE SCHEDULE (2012), *available at* http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3__Toxics/Fee%20Schedule(1).pdf.

124. Interview with Nabil Al-Hadithy, Sec'y, City of Berkeley Cmty. Envtl. Advisory Comm'n, in Berkeley, Cal. (Sept. 15, 2012).

125. City of Berkeley, Cal. Toxics Mgmt. Div., Toxics Management Division Budget (July 1, 2010) (on file with City of Berkeley, Cal. Toxics Management Division).

126. *Id.*

127. Telephone Interview with Geoff Bowman, Health & Safety Chief, Bayer Corp. (Sept. 29, 2012).

128. *Id.*

129. *Id.*

Table 4: Cost and Resources			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Steady Funding Source	Somewhat	Somewhat	While TMD has a funding source for submittal reviews they rely on the City's general fund to cover other program costs.
Fees can change with industry	Yes	Yes	Fee Schedule can change if it is approved by city council
Recommendation: TMD should perform a cost analysis to determine if the funding mechanism is sufficient for cost recovery and is sustainable.			

D. Enforcement

TMD has a number of tools to enforce the BENDO. As the BENDO is a city ordinance, violation of any provision of the city ordinance is subject to administrative citation.[130] If a facility does not comply, it is sent a warning letter issuing a violation and a time frame for compliance.[131] If the deadline passes, the facility is subject to an administrative citation with a penalty of up to $500 per day.[132] The City Attorney is authorized to take further action such as revoking the facility's zoning certificate or placing a lien on the property.[133] In addition, the enforcement may be

130. Interview with Nabil Al-Hadithy, *supra* note 124.
131. *Id.*
132. *Id.*
133. *Id.*

publicized through a press release based on the discretion of the TMD manager.[134]

There have not been any cases of enforcement for noncompliance since the BENDO was enacted in 2006.[135]

Table 5: Enforcement			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Robust Enforcement Program	Yes	Yes	TMD has a robust enforcement policy with the ability to levy fines and revoke permits.
Enforcement Actions Publicized	Yes	N/A	Enforcement actions can be publicized through a press release.
Recommendations: None			

E. User Embeddedness

a. Information's Perceived Value in Achieving User Goals

The BENDO has a number of different users including policy analysts, academics, and the media. These users are interested in the BENDO because it provides value as a case study for local nanoparticle regulatory efforts. Berkeley citizens may take interest in the BENDO because of their concern for their health. Finally, City staff use the BENDO for city planning and emergency response decision making.

134. *Id.*

135. CITY OF BERKELEY, CAL. TOXICS MGMT. DIV., ENFORCEMENT CASES (2006-2010) (on file with City of Berkeley, Cal. Toxics Management Division).

The document analysis reveals that lay people are not accessing the BENDO data as frequently as professional users. This suggests that the BENDO is not meeting the needs of the private citizenry, a user group to which the BENDO was designed to cater.

Table 6: Public Record Reviews Berkeley BENDO 2006-2009[136]	
User Group	**Number of Requests**
Journalist	6
Academic	13
Public Agency	8
Private Citizen	1

b. Compatibility with User's Decision-Making Routines

Compatibility of information with user decision-making routines is determined by time and place.[137] BENDO data is not electronic, as data is kept in TMD paper files. A file review request must be submitted before the data can be retrieved. Files are not available remotely and are not sent by fax or PDF to users. TMD should consider making the information available online to users as this would reduce the time and cost to obtain this information and make it available to a larger audience.

Furthermore, the data submissions are not standardized. The disparate format of the submittals makes it difficult to compare data. TMD should either standardize submittals by providing a formatted template or synthesize data into a form that allows easy comparison of data.

136. CITY OF BERKELEY, CAL. TOXICS MGMT. DIV., BENDO RECORDS (2006-2009), *available at* http://www.ci.berkeley.ca.us/uploadedFiles/Planning_and_Development/Level_3_-_Toxics/File%20Review%20rev031912.pdf (providing the form to submit for public access to Toxics Management Division records, as reviewed by the author).

137. Weil et al., *supra* note 55, at 169.

c. Comprehensibility

BENDO submittals are technical in nature, containing information on toxicology, engineering controls, and chemical properties. While these submittals may be comprehensible to those with technical knowledge of nanotechnology, they may not be as comprehensible to lay users—such as citizens wanting to know the risks of living close to a facility that generates nanoparticles. TMD should thus consider simplifying information or actively encouraging user groups who can provide this service.

Table 7: User Embeddedness

Ideal Type Category	Interview	Document Analysis	Summary
Information's Perceived Value in Achieving User Goals	Somewhat	Somewhat	It is likely that professional users achieve more value from BENDO data than lay persons.
Compatibility with User's Decision Making Routines	No	No	BENDO's data is not easy for users to access.
Comprehensibility	No	No	Data is not standardized.
Recommendations: TMD should simplify and standardize BENDO data. TMD should provide this information on the internet.			

F. Discloser Embeddedness

Discloser embeddedness occurs when user decisions are communicated to disclosers, causing disclosers to adjust their

behavior.[138] In the case of the BENDO, the desired behavioral change is risk reduction. The media have played a role in broadcasting the BENDO to disclosers. For instance, Bayer Corporation stated that it is affected by the media attention and has adjusted its practices accordingly.[139] However, this is not a sustainable pathway of communication between users and disclosers. TMD should provide a method for tracking user decisions and making this information available publically. One such solution would be to solicit users to fill out a survey indicating their decisions and preferences.

Table 8: Disclosure Embeddedness			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Disclosers have access to user decisions and alter behavior in response to user decisions.	Somewhat	N/A	Media play a role in broadcasting BENDO to disclosers. BENDO does not provide a communication pathway for disclosers to access user decision making.
Recommendation: TMD should solicit user decisions and make them publically available.			

G. Feedback and Evaluation Mechanism

The BENDO lacks a formal evaluation formal feedback and evaluation mechanism. Neither users nor disclosers are solicited for feedback. In addition the BENDO has not been formally reviewed and evaluated since its inception in 2006. TMD should

138. *Id.*
139. Telephone Interview with Geoff Bowman, *supra* note 127.

implement a formal feedback and evaluation mechanism and use it to inform policy revisions.

Table 9: Feedback and Evaluation Method			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Feedback solicited from Disclosers and Users	No	No	TMD has no feedback mechanism for the BENDO
Policy is internally reviewed and revised	No	No	TMD has no review mechanism for the BENDO
Recommendation: TMD should implement a feedback and evaluation mechanism to inform policy revisions to the BENDO.			

H. Involvement of User Groups

The BENDO has attracted the attention of academics, national media, and scholarly institutes. These user groups have helped to publicize the BENDO and bring it to the attention of the regulated community and concerned citizenry. TMD maintains contact with user groups such as the Woodrow Wilson Institute's Project on Emerging Nanotechnologies (PEN), and the University of San Francisco's Program on Reproductive Health and the Environment.[140] Although these groups have been concerned with the BENDO's implications as a regulatory policy, they have not been involved in translating the data that the BENDO has collected.[141] Although the BENDO regulatory policy has been publicized, the facility submittals have not been simplified or synthesized.[142] Hence, TMD should solicit user groups who can simplify and distribute such data to the public.

140. Interview with Nabil Al-Hadithy, *supra* note 116.
141. *Id.*
142. *Id.*

Table 10: Involvement of User Groups			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
User Groups are supported	Yes	N/A	BENDO conducts outreach and works cooperatively with user groups.
Policy is publicized	Yes	Yes	BENDO is widely publicized by user groups.
Complex data is translated	No	N/A	No data has been translated by user groups.
Recommendation: TMD should solicit and create relationships with user groups that have experience simplifying data for the general public.			

I. Extent to Which Existing Regulatory Programs are Leveraged

TMD implements a number of environmental programs. As a certified unified program agency, TMD is responsible for regulating facilities that handle hazardous materials and hazardous waste. All of the facilities regulated by the BENDO are also permitted for managing hazardous materials or hazardous waste. Because of this overlap, TMD leverages its environmental programs to support the BENDO. TMD saves resources, called unified inspection, by conducting simultaneous inspections at facilities for all of the programs it regulates; the BENDO is incorporated into this inspection process. The City's administrative enforcement process described earlier is another example of how the BENDO leverages other environmental programs.

Table 11: Extent to Which Other Regulatory are Leveraged			
Ideal Type Category	**Interview**	**Document Analysis**	**Summary**
Existing regulatory programs are leveraged	Yes	Yes	CUPA programs are leveraged
Leveraged programs fill deficiencies	Yes	Yes	Administrative Enforcement program is leveraged.
Leveraged programs save resources	Yes	Yes	Staff resources are saved by conducting unified inspections.
Recommendations: none			

V. CONCLUSION

Overall, the BENDO has many elements of a practical ideal transparency policy. In order to fully implement a successful transparency policy model, the City of Berkeley should focus on creating a formalized and standardized approach to correcting the deficiencies identified in this study.

APPENDIX A

Instrument A: Focused Interview Questions

For City of Berkeley Government Agencies
Interviewee(s) Identified: Nabil Al-Hadithy
City of Berkeley Toxics Management Manager

1. Please describe your institutional affiliation and the type of work that you do with your organization.
2. Probe: How does nanotechnology fit into your work?
3. How do you decide what constitutes a nanoparticle?
4. Probe: Why should these materials should be disclosed?
5. How important are existing government programs in determining how the regulation was implemented? For example, existing infrastructure, cooperation between regulatory agencies, state resources, etc.?
6. How do you see government mandates, legal issues, or program requirements affecting what you can do?
7. What is your regulatory authority?
8. Do you offer any interpretation of what the data might mean to the end user? Please describe.
9. Describe the reasons for instituting the BENDO.
10. Probe: Did the lack of currently available information on nanotechnology constitute a public risk?
11. How does the BENDO mitigate this risk?
12. Describe the review and approval process once the disclosure report is received.
13. Are variable results acceptable?
14. What are the mechanisms by which end-users access information?
15. How many information requests have you had since the regulation was enacted?
16. How many information requests do you receive in a month, in a year?
17. What percentage of information requests come from individuals, NGOs, consultants, litigators, etc.?

18. How long does it take end users to receive information once requested?
19. How are requests for information processed?
20. How does the BENDO integrate other regulatory policies to achieve its desired outcome?
21. How does the City of Berkeley Toxics Management Division (TMD) address non-compliance?
22. What enforcement resources does TMD employ?
23. How is the regulation funded?
24. Is the funding sustainable?
25. Who are the end users of the data/information?
26. What impact do you think your disclosure policy has had on the public? What are the most important ways in which these studies get communicated to the public—through media, government outreach, NGO activities, etc.?
27. Probe: Do you have an outreach program that informs the public how to access BENDO information? Explain.
28. Who are the intended users?
29. Probe: Do users have the will, capacity, and cognitive tools to improve their choices through BENDO information? Explain.
30. How are disclosers identified?
31. What is the relationship between the users and the disclosers?
32. Probe: Explain how BENDO influences the decisions of users and disclosers in the following areas:
    a. Risk assessment
    b. Risk mitigation
    c. Commercial manufacturing
    d. Economic decisions
33. Describe the methods of communication between the regulatory agency and the regulated community.
34. How is outreach conducted to the regulatory community?
35. How are trade secrets protected?

36. What is the security policy for confidential information?
37. Probe: Describe other policies that minimize economic disincentives to disclosers.
38. How does TMD insure that information is comprehensible to users?
39. What is the role of intermediaries, if any?
40. What user group(s) access the BENDO data?
41. Probe: Does the BENDO data contribute to the goals of the user group(s)? Explain.
42. Does TMD have a feedback and evaluation mechanism? Describe.
43. What metrics are taken into account?
44. How are metrics recorded?
45. What types of data analysis is being conducted currently or will be conducted in the future?
46. Has regulatory policy influenced behavioral changes in disclosers? Explain.
47. That's it for my questions. Do you have anything to add or do you have any specific question for me?

APPENDIX B

Instrument B: Focused Interview Questions

For Private Industry
Interviewee(s) Identified: Geoff Bowman
Bayer Corporation Health and Safety Chief

1. Please describe your institutional affiliation and the type of work that you do with your organization.
2. Probe: How does nanotechnology fit into your work?
3. How do you see government mandates, legal issues, or program requirements affecting what you can do?
4. Do you believe the BENDO will assist in risk assessment for the following end users?:
    a. The Government

b. The Public

5. What kind of influence, if any (and how much), do you think nanoparticle disclosure policy is having or will have on the production decisions of industry?
6. Describe the methods of communication between you and the TMD.
7. What costs does the BENDO impose?
8. Do you have any concerns regarding trade secret information? Explain.
9. Has your management of engineered nanoparticles changed as a result of the BENDO? Explain.
10. Probe: In relation to risk reduction risks or improve performance?
11. That's it for my questions. Do you have anything to add or do you have any specific question for me?