

# **Taking a Proactive Approach Towards Responsibility: Indications of Nano Policy-Making around the World**

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## **Abstract**

In this paper, we hypothesize that the development of normative materials dealing with nanotechnology can be used to indicate the level of action being taken worldwide towards the responsible development of nanotechnologies. We also look at these indications of action in light of the number of reports, articles, and general agitation about the *need* to take some sort of proactive steps, to see if these reports have influenced the level of action being taken. At the moment, very little in the way of regulation has been enacted by national governments in regard to nanotechnology and its potential environmental, health and safety implications. However, there are indications that a small number of government agencies, industrial organizations, and advocacy-oriented NGO's are developing normative materials and funding projects that can be seen as some of the first steps taken towards promoting the responsible development of nanotechnologies.

## **Introduction**

Since 2005, the Center for the Study of Ethics in the Professions has been collecting in the NanoEthicsBank, a publicly accessible database, materials dealing with the responsible development and use of nanotechnology. The materials in this database are divided into two categories, descriptive materials, and normative materials, such as codes of ethics, which direct or prescribe conduct. While gathering this material for inclusion in the NanoEthicsBank, we noticed a number of trends in the types of documents being published. Between 2000 and 2004, the majority of descriptive materials spoke generally about the possible societal and ethical effects of nanotechnology research and development, and voiced a need for a proactive approach to be taken. After 2004, the number of normative materials, seeking to direct actions in regard to the societal implications of nanotechnology, went up considerably. This paper will first provide a summary of the findings of our research on salient descriptive materials that call attention to social and ethical implications, and compare this to the type and number of salient normative materials in the NanoEthicsBank. It will finally provide a brief glimpse into the levels of funding around the world for ethical, societal, and legal implications of nanotechnology development.

## **Salient Materials that Call Attention to Social and Ethical Implications**

During the past three years, the Center for the Study of Ethics in the Professions has been working on the development of the NanoEthicsBank, a publicly accessible database of materials covering the social and ethical implications of nanotechnology.<sup>1</sup> During this time, we have noticed a distinct trend in the kinds of descriptive materials being published in the area of nanoethics. A large number of these descriptive materials are reports published by government agencies, the insurance sector, scholarly non-governmental organizations such as the Woodrow Wilson International Center for Scholars, and more advocacy oriented non-governmental organizations (NGO's) such as Friends of the Earth and the ETC Group, that call attention to the ethical and societal implications of nanotechnology, both positive and negative. Reports were considered salient when they had attracted attention or been cited in three or more reports, articles, or online publications that appeared to be widely read and were included in the NanoEthicsBank. What emerged as a dominant issue in many of these reports is the need for attention to the potential risks of nanotechnology research and development, and an emphasis on the need for action of some kind to be taken.

### **Areas of Attention**

Of the sixty-three reports analyzed (see Appendix I), four main themes emerged as areas meriting study and possible action. The foremost concerns in these reports were nanotechnology's implications for human health and the environment. Around 65% directly mentioned human health and safety, and 60% mentioned environmental effects (reports often mentioned both), while the majority of the remaining reports dealt less directly with these topics (reports that emphasized on one topic such as food safety, adequacy of current EHS regulations, etc.) Government reports, reports from the insurance sector, and reports by environmental NGO's concentrated heavily on these two areas, with the government and insurance reports often discussing concerns about workplace safety. The NGO's concentrated more on concerns over potential environmental pollution, the use of nanomaterials in consumer products, and at least four NGO reports called for either a moratorium on nanotechnology research, such as the ETC Group's report, "The Big Down" published in 2003, or called for mandatory labeling of products containing nanomaterials, as the Friends of the Earth and

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<sup>1</sup> For further information and access, see <http://hum.iit.edu/~csep/NanoEthicsBank/>

the International Center for Technology Assessment did in 2006 in a petition to the U.S. Food and Drug Administration.<sup>2</sup>

The second theme that emerged was the need for government action, namely the need to study the adequacy of current risk governance and legislation (43%), the need for a strong research plan and funding for identifying potential environmental health and safety risks of nanotechnology (27%), and the need to develop a comprehensive risk framework to address these risks when identified (29%). The Woodrow Wilson International Center for Scholars' Project on Emerging Nanotechnologies has alone produced over twenty-five different reports and papers on these issues, many of which analyze one aspect in detail and offer recommendations for ways to move forward.

The third area that came up frequently in a number of reports was the need for an open dialogue between all stakeholders involved in nanotechnology (34%). Reports put out by U.S. government agencies such as the EPA emphasized the need for an ongoing, open dialogue to occur between industry, academic researchers, and agency officials. In the European Union and the U.K., this open dialogue also included the public. NGO's and scholarly organizations were less concentrated on this issue of public involvement, though the Project on Emerging Nanotechnologies and a number of universities have published a series of surveys looking at public opinion regarding nanotechnology, especially its medical use and its inclusion in consumer products. This focus on public engagement seems to emphasize not only a wish to ensure the safe and ethical development of nanotechnology through including all stakeholders in decision-making processes, but also a desire for such a dialogue to help mitigate fears about the potential risks of nanotechnology. Fears that nanotechnology will follow the same path as biotechnology, which met a strong backlash in many parts of the world, may be at least one factor behind this emphasis.

The reports from government agencies, the insurance sector, scholarly NGO's, and advocacy oriented NGO's gave far less attention to other ethical issues, such as questions about human enhancement (14%), privacy (6%), and the development of a nanotechnology divide between developed and less developed areas of the world (13%). A number of specialists in ethics and science and technology studies have joined the discussion surrounding nanotechnology. Though a large number of articles, books, and even journals have been published that emphasize on these issues, these materials are not attracting the attention of the media and government agencies as major reports have.

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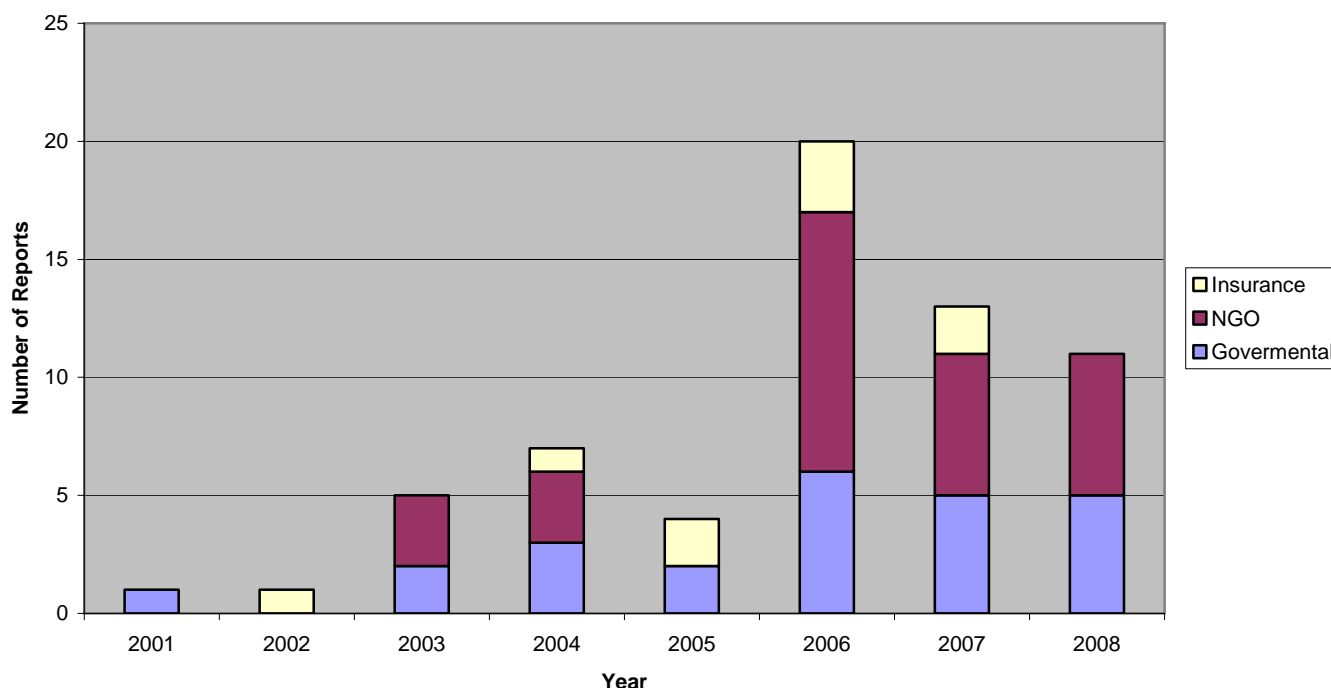
<sup>2</sup> "CTA and Friends of the Earth Challenge FDA to Regulate Nanoparticles at FDA Hearing." International Center for Technology Assessment Press Release. October 10, 2006. H[http://www.icta.org/press/release.cfm?news\\_id=21H](http://www.icta.org/press/release.cfm?news_id=21H).

## **Focusing of Attention on Societal and Ethical Implications**

The number, location, and emphasis of reports published by year reveals a change and maturation in how these organizations understand the societal and ethical implications of nanotechnology. In September 2000, the United States held a conference entitled, “Societal Implications of Nanoscience and Nanotechnology”, which sought to identify some of the potential areas for research into the ethical implications of nanotechnology. This conference, the first of its kind, helped begin the discussion about possible societal effects, and by the time the second conference was held in 2003, scholarship in this area had already begun. In 2004, two of the most influential reports came out from organizations located in Europe, reports that were continually referred to in subsequent U.S. and E.U. government reports and scholarly articles, “Small Matters, Many Unknowns,” by Swiss Re, and “Nanoscience and Nanotechnologies: Opportunities and Uncertainties” published by the United Kingdom’s Royal Society and Royal Academy of Engineering. That same year, “Industrial Application of Nanomaterials: Chances and Risks” was produced by the Future Technologies Division of Technologiezentrum in Germany. These European reports may have brought more stakeholders to the table, as it is around this period that environmental groups such as Friends of the Earth began to enlarge their advocacy efforts around nanotechnology. Of all the government reports from 2001-2008, 30% were from U.S. agencies, 22 from the E.U., 13 from the U.K., 17% were from German agencies, and 4% from Australia, Ireland, and Switzerland respectively.

The year 2006 saw the largest number of reports published, with six of the twenty reports coming from governmental agencies, eleven from NGO’s, and three from insurance and for-profit organizations. The vast majority of these reports differ from the 2004 reports in that most all of them deal with only one aspect of nanotechnology, such as the regulation and labeling of cosmetics containing nanoscale materials, or the assessments of the adequacy of current regulation and risk assessment strategies in regard to nanotechnology. From this information, it looks as if the 2004 reports helped concentrate attention on some of the main questions about nanotechnology R&D. The following two years saw a concentrating of attention on specific issues. By 2006, the overall understanding expressed in these reports was an acknowledgement of the need for more scientific evidence about the potential environmental and health effects of engineered nanoparticles, but a clear emphasis, especially by government, scholarly organizations, and advocacy groups, on the need to do *something*, even in the face of ignorance and uncertainty.

**Figure 1: Number of Risk Reports by Year, January 2001-October 2008**



### **Normative Materials: Indicators of Action**

As of November 2008, there have been no mandatory regulations passed by national governments that specifically address nanotechnology. The U.S. Environmental Protection Agency is attempting to use existing regulations to handle products that use silver nanoparticles, but efforts in this area have met with some criticism and confusion.<sup>3</sup> A number of agencies in the E.U. and U.S., including the EPA and NIOSH, have or are in the process of developing research strategies for addressing potential environmental, health, and safety (EHS) risks posed by nanotechnology, as well as developing oversight frameworks for nano research and development.

Perhaps more interesting is how some local governments, NGO's, and industry organizations have taken a leading role by developing codes of conduct and risk assessment schemes (such as plans that assist companies to identify the level of risk associated with a product or process utilizing engineered nanoparticles and to develop ways for mitigating these risks) on their own or partnered with other organizations. The normative materials covered in this review include codes of conduct, risk assessment strategies, reporting schemes, uses of precautionary principles, standards approved or still

<sup>3</sup> For example, see Feder, Barnaby. "New Device for Germophobes Runs into Old Law." *New York Times*. March 6, 2008. <http://www.nytimes.com/2008/03/06/business/smallbusiness/06sbiz.html?scp=10&sq=Feder&st=nyt>.

in the process of development by national and international standard-setting agencies, and research strategies approved by national and international governments. The following sections will give examples of the normative documents and programs we were able to collect, and analysis of the possible trends of proactive efforts these documents might represent.

## **1. Codes of Conduct**

The Chemical Company BASF developed the first example of a code of conduct in 2004, which speaks both of the company's duties to workers, investors, and clients, but also towards a commitment to assist in developing relevant standards for nanotechnology as a basis for future legislation.<sup>4</sup> This same company also helped develop the "Responsible Nanocode," which sprang from a cooperative partnership in the United Kingdom between industry and academia. The project involved BASF, the Royal Society, the University of Cardiff, TESCO (a company), the Nanotechnology Industries Association, and Insight Investment. Begun in November of 2006 during a workshop involving seventeen European companies with an interest in nanotechnologies, the workshop participants agreed to create a voluntary code of conduct based on principles that represented the concerns of a wide variety of stakeholders. The final draft of the code lists seven principles for organizations to follow, and then lists indicators of good practice that show these principles are being followed. For example, the code calls for each company to proactively engage with its stakeholders and be responsive to their views in the development or use of nanotechnologies, and as a sign of good practice, calls for company boards' to provide, "clear disclosure of how stakeholder views have been considered and taken into account."<sup>5</sup> The Responsible Nanocode Working Group held a public consultation on the first draft of the code in February, and published a final draft of the code in May of 2008. The Working Group is now working on developing a document to help organizations do an independent assessment of how well they are following the Code, and are discussing the legal implications of the Code in the context of national and regional regulatory frameworks.

In 2007, the European Commission launched a public consultation about a proposed code of conduct for nanotechnology research, as called for in the guidance document, "Nanosciences and Nanotechnologies: an Action Plan for Europe 2005-2009". In February of 2008, the "Code of Conduct for Responsible Nanoscience and Nanotechnology Research" was approved. Based on precautionary principles, this voluntary code covers seven general principles, including sustainability,

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<sup>4</sup> See "BASF Code of Conduct – Nanotechnology. BASF Global 2004.

[Hhttp://www.corporate.basf.com/en/sustainability/dialog/politik/nanotechnologie/verhaltenskodex.htm?id=5QJSoC8AZbcp\\*-iH](http://www.corporate.basf.com/en/sustainability/dialog/politik/nanotechnologie/verhaltenskodex.htm?id=5QJSoC8AZbcp*-iH).

<sup>5</sup> "Responsible NanoCode Consultation Draft" 17 September 2007. Responsible Nanocode Web site [Hhttp://www.responsiblenanocode.org/pages/progress/index.html](http://www.responsiblenanocode.org/pages/progress/index.html)H. Last viewed 31 October 2008. p.8.

precaution, inclusiveness, and accountability.<sup>6</sup> The main goal of this code of conduct is to help research institutes, universities, and companies in the EU ensure the safe development and use of nanotechnologies in the face of knowledge gaps and uncertainties about the future impact of these technologies on human health and the environment.

## **2. Risk Assessment Schemes and Development of Best Practices**

Private companies, large industrial players, and NGO's have begun to try to answer the question of how to deal with the possible human health risks posed by engineered nanoparticles. At least in one instance, such partners have worked together to develop a free guidance document that helps interested companies begin to evaluate the potential risks of their nano products and processes. In June of 2005, the chemical company DuPont and the NGO Environmental Defense Fund began developing the "Nano Risk Framework" which helps answer questions an organization should consider in developing applications using nanomaterials, including providing a way to address areas of incomplete or uncertain information using "reasonable assumptions and appropriate risk management practices."<sup>7</sup> The framework also includes guidance on how to communicate information and decisions to stakeholders. The freely available risk framework includes a number of case studies that have been developed showing how Dupont has used the Nano Risk Framework to analyze some of its own nanoparticle-containing products.

When released, the framework was criticized by other environmental and civic society groups, including the ETC Group, Greenpeace, and the United Steelworkers of America, who published an open letter rejecting the framework on the grounds that historically, voluntary regulations are used to delay or prevent the adoption of more rigorous, mandatory regulations, and called the framework, "...at best, a public relations campaign that detracts from urgent worldwide oversight priorities for nanotechnology."<sup>8</sup>

Finally, Japan is at the beginning stage of assisting nano enterprises in developing best practices for the workplace. In 2006 a research project on the proper on-site handling methods for nanotechnologies in research manufacturing was implemented, which helped produce a series of guidelines that are especially designed for nanoparticles, such as carbon nanotubes, used in industrial settings. These voluntary guidelines are being made available until further research on risk assessment

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<sup>6</sup> "Commission adopts code of conduct for responsible nano research." *Cordis News*. February 11, 2008  
H[http://cordis.europa.eu/fetch?CALLER=EN\\_NEWS&ACTION=D&SESSION=&RCN=29114](http://cordis.europa.eu/fetch?CALLER=EN_NEWS&ACTION=D&SESSION=&RCN=29114)H.

<sup>7</sup> "Nano Risk Framework Executive Summary" June 21, 2007.  
H<http://www.nanoriskframework.com/content.cfm?contentID=6498>H

<sup>8</sup> "Civil Society-Labor Coalition Rejects Fundamentally Flawed Dupont-ED Proposed Framework." April 12, 2007. ETC Group Web site. H[http://www.etcgroup.org/upload/publication/610/01/coalition\\_letter\\_april07.pdf](http://www.etcgroup.org/upload/publication/610/01/coalition_letter_april07.pdf)H.

methodologies has been completed and final handling methods for these nanoparticles have been determined.<sup>9</sup> In a similar effort, CSEP is currently conducting a survey of companies and laboratories that work with engineered nanoparticles to gather existing examples of best practices and workplace safety guidelines.

### 3. Reporting Schemes

Reporting schemes that ask industry to submit information about the types and potential dangers of the nanomaterials they develop or manufacture, are one way of gathering information about the potential risks of these particles. As of April 2008, we have found one mandatory and two voluntary reporting schemes currently in existence. In December of 2006, the Berkeley City Council passed the Manufactured Nanoscale Health and Safety Ordinance that requires, “All facilities that manufacture or use manufactured nanoparticles to submit a separate written notice of the current toxicology of the materials reported, to the extent known, and how the facility will safely handle, monitor, contain, dispose, track inventory, prevent releases, and mitigate such materials.”<sup>10</sup> The ordinance came about when the city’s hazardous waste manager, Nabil Al-Hadithy, began asking questions about the possible safety risks of nanomaterials after Lawrence Berkeley National Lab filed an environmental impact statement in 2004 to build a “molecular foundry” to make nanoparticles. At the time of passing the ordinance, no companies in the area came under the new rules, and the National Laboratory was exempt, though a spokesman said they would be voluntarily submitting information.<sup>11</sup> The Cambridge City Council requested an advisory panel to look into the feasibility of adopting similar guidelines in 2007. While the advisory committee did not recommend the council to enact an ordinance regulating nanotechnology when it was published in July of 2008, they did recommend that the city council establish an inventory of facilities that utilize nanotechnology, offer technical assistance to help firms and institutions evaluate their existing health and safety plans to limit workers' exposure to nanomaterials, offer up to date health information to residents on products

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<sup>9</sup> Ishizu, Saori, Mizuki Sekiya, Ken-ichi Ishibashi, Yumi Negami, and Masafumi Ata. “Toward the Responsible Innovation with Nanotechnology in Japan.” *Journal of Nanoparticle Research*. 10:2 (February 2008) 248.

<sup>10</sup> Al-Hadithy, Nabil A. “Manufactured Nanoparticle Health and Safety Disclosure” December 5, 2006. Berkeley City Council Web site. [Hhttp://www.ci.berkeley.ca.us/citycouncil/2006citycouncil/packet/120506/2006-12-05%20Item%2013%20Manufactured%20Nanoparticle%20Health%20and%20Safety%20Disclosure-Supp.pdf](http://www.ci.berkeley.ca.us/citycouncil/2006citycouncil/packet/120506/2006-12-05%20Item%2013%20Manufactured%20Nanoparticle%20Health%20and%20Safety%20Disclosure-Supp.pdf)H.

<sup>11</sup> Feder, Barnaby. “Teeny-Weeny Rules for Itty-Bitty Atom Clusters” *New York Times* January 14, 2007. [Hhttp://www.nytimes.com/2007/01/14/weekinreview/14feder.html](http://www.nytimes.com/2007/01/14/weekinreview/14feder.html)H.



containing nanomaterials, and to track toxicological research on nanomaterials the evolving status of regulations and best practices concerning nanoscale materials.<sup>12</sup>

The U.S. and the UK have developed two voluntary reporting schemes. Britain's "Voluntary Reporting Scheme for Engineered Nanoparticles" is a temporary experiment that ran from September 2006 to September 2008. The program asks for data that can be provided on manufactured nanomaterials from anyone involved in the manufacture or use of engineered nanomaterials, or anyone involved in nanoscience research or managing wastes consisting of engineered nanoscale materials.<sup>13</sup> The goal of the scheme is to provide an indication of the kinds of nanomaterials currently in development and production to help inform policy-making decisions and to concentrate efforts and funding on areas which are relevant to the UK's current nano manufacturing and research base. As of July 2008, eleven submissions have been received, 2 from academia and nine from industry.<sup>14</sup> After September 2008, the reporting scheme will be subject to a six-month review by the U.K's Department for Environment, Food and Rural Affairs, as well as a public consultation on its effectiveness. In January of 2008 the United States Environmental Protection Agency (EPA) launched the Nanoscale Materials Stewardship Program, which "...will help provide a firmer scientific foundation for regulatory decisions by encouraging submission and development of information including risk management practices for nanoscale materials."<sup>15</sup> The program includes a basic program that invites participants to report available data on engineered nanoscale materials, and an in-depth program in which participants will voluntarily develop data and testing methods over a longer time frame. As of October 2008, twenty-five organizations had submitted material under the basic program covering more than 113 nanoscale materials, and at least three organizations were participating in the in-depth program.<sup>16</sup>

#### **4. Precautionary Principles**

One area of discussion that we have been following closely since the inception of the NanoEthicsBank is the use of precautionary principles in discussions about the oversight of

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<sup>12</sup> Cambridge Public Health Department, Nanomaterials Advisory Committee. "Recommendations for a Municipal Health and Safety Policy for Nanomaterials: A report to the Cambridge City Manger." Cambridge Public Health Department. July 17, 2008. H[http://www.cambridgepublichealth.org/publications/July\\_17\\_08\\_Nano\\_Recommendations.pdf](http://www.cambridgepublichealth.org/publications/July_17_08_Nano_Recommendations.pdf)H

<sup>13</sup> "UK Voluntary Reporting Scheme for Engineered Nanoscale Materials." United Kingdom Department for Environment, Food and Rural Affairs. H<http://www.defra.gov.uk/ENVIRONMENT/nanotech/policy/pdf/vrs-nanoscale.pdf>H p.2.

<sup>14</sup> Department for Environment Food and Rural Affairs. "The UK Voluntary Reporting Scheme for Engineered Nanoscale Materials: Seventh Quarterly Report." July 2008. <http://www.defra.gov.uk/environment/nanotech/pdf/vrs-seventh-progress-report.pdf>.

<sup>15</sup> Environmental Protection Agency. "Nanoscale Materials Stewardship Program" February 21, 2008 Environmental Protection Agency Web site. H<http://www.epa.gov/oppt/nano/stewardship.htm>H Last viewed 2 November 2008.

<sup>16</sup> Environmental Protection Agency. H<http://www.epa.gov/oppt/nano/stewardship.htm>H Last viewed 2 November 2008.

nanotechnology. The precautionary principle, which was most prominently mentioned in the Swiss Re report “Nanotechnologies: Small Matter, Many Unknowns” prescribes that measures should be taken to protect people and the environment at an early stage when there is a potential for serious harm, even when there is a lack of scientific evidence demonstrating harm. The Swiss report directly calls for the use of this principle in relation to nanotechnology, stating “In view of the dangers to society that could arise out of the establishment of nanotechnology, and given the uncertainty currently prevailing in scientific circles, the precautionary principle should be applied whatever the difficulties.”<sup>17</sup> The precautionary principle has been cited most frequently in normative materials originating from Europe, though discussions about its application in regard to nanotechnology have occurred in the U.S., Japan, and other regions.<sup>18</sup>

In 2004, a report entitled “Nanotechnology and Regulation within the Framework of the Precautionary Principle” was presented to the European Parliament. According to this report, the Precautionary Principle for the European Union states that scientific uncertainty is no reason for inaction if there might be immense adverse effects. It suggested a number of potential actions that could be taken and mentioned the REACH regulations, which handle the registration, evaluation, authorization and restriction of chemical substances, as potentially also covering engineered nanoparticles.<sup>19</sup> It is interesting to note that though the 2007 REACH regulations (which are themselves underpinned by the precautionary principle), do not specifically mention engineered nanoparticles. According to a Q&A page on REACH from the European Union web site, nanoparticles are considered to fall under these regulations, and the EU is in the midst of funding research to see whether the registration and information requirements under REACH are adequate to address the potential risks from particles at the nano-scale.<sup>20</sup>

A few organizations have gone further, and used the precautionary principle to justify their actions in passing regulations on the use of nanomaterials. In the UK, the Soil Association, a UK environmental organization that sets standards for organic food and farming that exceed statutory organic standards, set a standard in the beginning of 2008 that prohibits food products or ingredients produced using nanotechnology from being labeled organic. In their justification of this ban on their

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<sup>17</sup> Hett, Annabelle. “Nanotechnology: Small Matter, Many Unknowns.” Swiss Re, 2004. [http://www.swissre.com/resources/31598080455c7a3fb154bb80a45d76a0-Publ04\\_Nano\\_en.pdf](http://www.swissre.com/resources/31598080455c7a3fb154bb80a45d76a0-Publ04_Nano_en.pdf) p. 48.

<sup>18</sup> For example, Ishiuzu, 253.

<sup>19</sup> European Parliament: “Nanotechnology and Regulation within the framework of the Precautionary Principle. Final Report for ITRE Committee of the European Parliament”. Haum, Petschow, Steinfeldt, Institut für ökologische Wirtschaftsforschung (IÖW) gGmbH, Berlin, 11 Feb 2004.

<sup>20</sup> Bowman, Diana and Geert van Calster. “Does REACH Go too Far?” *Nature Nanotechnology*. 2 (2007) 525-526. “Q & A on the New Chemicals Policy – REACH” European Commission, Enterprise and Industry. 2007. [http://www.ec.europa.eu/enterprise/reach/faq\\_en.htm](http://www.ec.europa.eu/enterprise/reach/faq_en.htm)

website, they specifically state that they have applied the precautionary principle to this case due to the current lack of safety testing being done by industry and governments.<sup>21</sup>

#### 4. Terminology and Standards

As of October 2008, we have located over seventy standards related to nanotechnology developed by national and international governmental and non-governmental standard-setting organizations. These include terminology standards, which are essential in ensuring the clear and precise communication of nanotech's benefits and risks between scientists, engineers, and policymakers, and other types of standards dealing with the metrology, testing, safe handling, and characterization of nanomaterials. China, South Korea, and the United Kingdom have developed standards of their own, and 28 countries are working with the International Organization for Standardization (ISO) in developing international standards.<sup>22</sup>

ASTM International and the British Standards Institution developed the first standards relating to nanotech, both of which defined the terminology used to describe nanotechnologies and nanoscale objects. BSI passed "PAS 71 Vocabulary – Nanoparticles" in 2005, two years before approving any other standards, and ASTM International approved their very first nanotechnology-related standard, "E-2456-06 Terminology for Nanotechnology," in 2006, a year before passing two more standards in 2007. Interestingly, both BSI and ASTM have made these standards available free of charge, to help avoid confusion in dialogues about nanotechnology, or as BSI states on their web site, for "encouraging the use of a common language for nanoparticle technologies."<sup>23</sup> ISO is also in the process of a series of standards for nanotech terminology, and published "ISO/TS 27678:2008 Nanotechnologies - Terminology and definitions for nano-objects -- Nanoparticle nanofibre and nanoplate" in early 2008.<sup>24</sup>

China was the first country to announce the development of standards for nanotechnology in 2004, and since 2005, the number of standards being released internationally has gone up steadily every year, (See figure 2) usually due to a standards setting organization releasing three or more

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<sup>21</sup> "Soil Association Standards Guide, Nanotechnology" Soil Association: Our Organic Standards, 2008. [Hhttp://www.soilassociation.org/web/sa/saweb.nsf/ed0930aa86103d8380256aa70054918d/444ed4dee8649ee18025739c003d0a49!OpenDocumentH](http://www.soilassociation.org/web/sa/saweb.nsf/ed0930aa86103d8380256aa70054918d/444ed4dee8649ee18025739c003d0a49!OpenDocumentH).

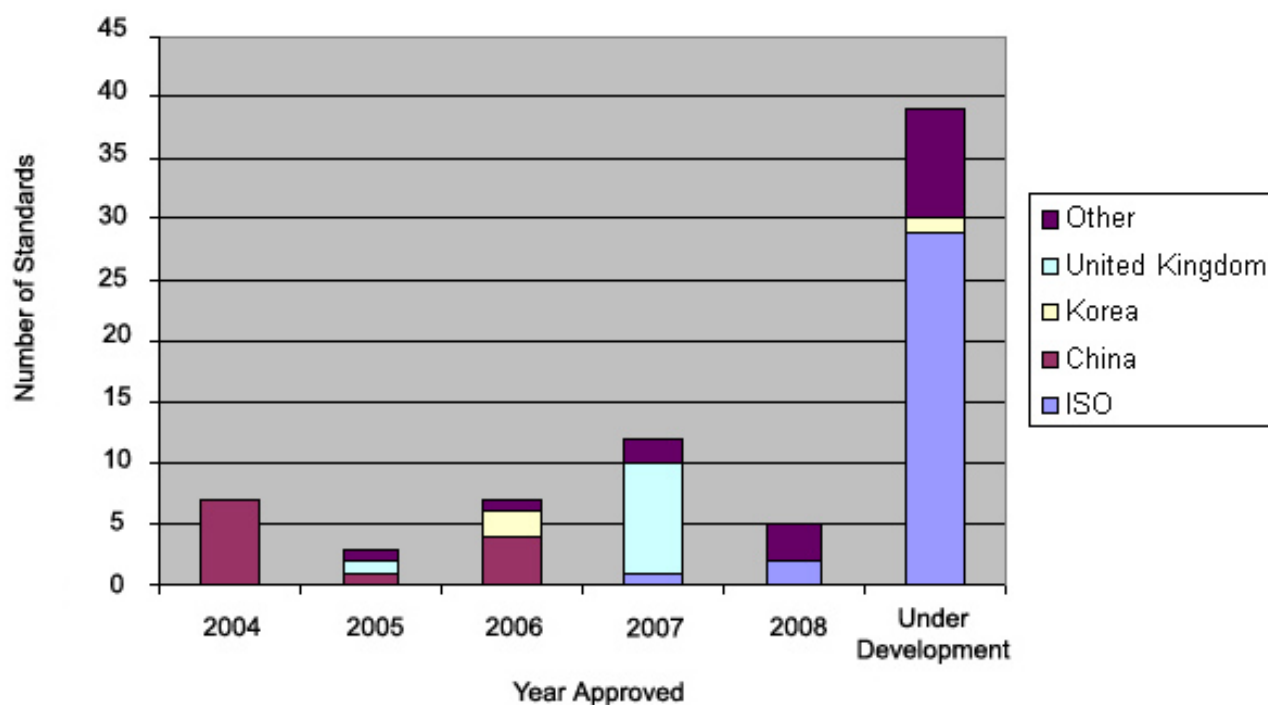
<sup>22</sup> "Business Plan ISO/TC 229: Nanotechnologies" Draft version April 23, 2007 International Organization for Standardization. [Hhttp://isotc.iso.org/livelink/livelink/fetch/2000/2122/4191900/4192161/TC\\_229\\_BP\\_2007-2008.pdf?nodeid=6356960&vernum=0](http://isotc.iso.org/livelink/livelink/fetch/2000/2122/4191900/4192161/TC_229_BP_2007-2008.pdf?nodeid=6356960&vernum=0) p. 6-7.

<sup>23</sup> British Standards Organization "Nanotechnologies." <http://www.bsi-global.com/en/Standards-and-Publications/Industry-Sectors/Nanotechnologies/>.

<sup>24</sup> International Standards Organization. "New ISO/TS 27687 will help defining nanotechnologies" 25 September 2008. <http://www.iso.org/iso/pressrelease.htm?refid=Ref1161>

standards at the same time. Currently thirty-seven standards are still under development that we know of, and no doubt many more will be developed as nanotechnology research and development continues. The types of standards being developed vary from the handling and disposal of nanomaterials, to best practices for labeling products containing nanomaterials. See Appendix II for a list of all the standards found. From the data collected, it looks as if standardizing terminology was the first step in this process, and only in the past two years have these organizations begun to set best practices for the handling, measuring, and classifying of nanotechnologies.

**Figure 2: Nano Standards Developed, January 2004-October 2008**



\*“Other” includes standards developed by ASTM International (10), IEEE (2), and the International Electrotechnical Commission.

## 5. Research Strategies

National governments have been slow to adopt nano-specific regulations. However, due to the rapid release of consumer products containing nanoparticles into the marketplace and urgings of scientists, activists, and reports such as those examined in earlier sections of this paper, a number of countries have developed and adopted research strategies to begin filling the knowledge gap about the potential human health and environmental effects of nanotechnology..

Japan has made nanotechnology research and development a priority for public science funding, though it has yet to adopt a nation-wide research strategy to investigate the environment, health and safety risks of nanotechnology. In a translation of Japan's strategic plan for nanotechnology research in the "Third Basic Plan for Science and Technology (2006-2010)", two of the main focuses of this research are the need for studies on the impact that nanotechnology has on society, and for developing standards for nanomaterials and nanotechnologies.<sup>25</sup> A year before the publication of this strategy, Japan held its first comprehensive symposium on the societal impacts of nanotechnology. The symposium led to a research project among four federal research institutes coordinated in efforts that produced a series of recommendations. In February of 2006, these institutes held the international symposium "Exploring the Small World: Role of Public Research Institutes" where the results of the research project were reported, and policy recommendations made.<sup>26</sup>

Partially spurred by the report by the "Nanoscience and Nanotechnologies: Opportunities and Uncertainties" published by the United Kingdom's Royal Society and Royal Academy of Engineering Royal Society, the United Kingdom's Department of Environment, Food and Rural Affairs (DEFRA) published the report "Characterizing the Potential Risks Posed by Engineered Nanoparticles," in 2005 that describes the agency's research aims in seeking to characterize the potential risks posed by engineered free nanoparticles. The second report published in 2007 of the same name summarizes the progress made on reaching these research goals, and addresses the recommendations made by the U.K.'s Council for Science and Technology for improving the program.<sup>27</sup>

Though the U.S.'s National Nanotechnology Initiative (NNI) included funding for the ethical and societal impacts of nanotechnology R&D as early as 2000, it took a few years for a coordinated research strategy to develop. Responding to the triennial review of the NNI by the National Academy of Sciences, the National Science and Technology Council recently published the "Strategy for Nanotechnology-Related Environmental, Health, and Safety Research" in February of 2008. Before this, a number of federal agencies such as NIOSH and the EPA had put out intermittent reports and guidance documents detailing their own strategy for addressing EHS risks, but no detailed national research strategy had been released.

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<sup>25</sup> Government of Japan. "Science and Technology Basic Plan (Provisional Translation)" March 28, 2006. [Hhttp://www8.cao.go.jp/cstp/english/basic/3rd-Basic-Plan-rev.pdf](http://www8.cao.go.jp/cstp/english/basic/3rd-Basic-Plan-rev.pdf)H. p. 65.

<sup>26</sup> Ishiuzu, 236.

<sup>27</sup> DEFRA "Characterizing the Potential Risks Posed by Engineered Nanoparticles: A Second UK Government Research Report." 2007. DEFRA web site. [Hhttp://www.defra.gov.uk/environment/nanotech/research/pdf/nanoparticles-riskreport07.pdf](http://www.defra.gov.uk/environment/nanotech/research/pdf/nanoparticles-riskreport07.pdf)H..

Along with the U.S. and the UK, Switzerland produced a guidance document entitled “Risk Evaluation and Management of Synthetic Nanoparticles 2006-2009” in February of 2006. This plan proposes the development of a code of conduct for nano research, the development of standards and best practices in conjunction with international organizations, the adaptation of existing legislation to deal with nanomaterials, a plan for EHS research and funding strategies, and plans to facilitate dialogue with stakeholders.<sup>28</sup>

Finally, the European Commission adopted the “Nanosciences and Nanotechnologies: an Action Plan for Europe 2005-2009” in June of 2005. This plan includes both very general goals such as developing models and standards for risk assessment and management, as well as specific actions that should be taken, such as the development of the code of conduct for nanotechnology research (as described earlier), and asking the European Group on Ethics in Science and New Technologies to carry out an ethical analysis of nanomedicine.<sup>29</sup> Even before the release of these two reports, the EU had funded a number of projects looking at the societal implications of nanotechnologies, including the Nanosafe project begun in April of 2003, which addressed topics of human health, dispersal into the environment, and preventative measures, and NanoSafe2, a continuation of the project that is currently underway<sup>30</sup>.

These research strategies developed by the U.S., U.K., Switzerland, and the EU seem to be a beginning answer to concerns mentioned earlier about human health and environmental risks, the need to study the adequacy of current risk governance, and the need for a strong research plan for addressing potential EHS risks. For most of these governments, the development of a clear research agenda happened after industries located within the country began using nanotech manufacturing processes and products, and in many countries like Japan, these agendas are still in an early stage of development.

In summary, while only a handful of nations, industrial organizations, and NGO’s have taken definitive steps in setting up initiatives, projects, or guidance documents that try to address the societal implications of nanotechnology, the actions of these organizations have helped concentrate attention on these important issues. Furthermore, national and international governments are also taking steps to establish clear research agendas to help investigate the possible health and

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<sup>28</sup> “OECD Extended Steering Group Meeting on Manufactured Nanomaterials 26027 October, 2006 Item 4: Tour de Table on Current Developments in Member Countries on the Safety of Manufactured Nanomaterials: Current Developments in Switzerland.” Organization for Economic Co-Operation and Development web site.

[Hhttp://www.oecd.org/dataoecd/57/41/37774728.pdf](http://www.oecd.org/dataoecd/57/41/37774728.pdf)H

<sup>29</sup> “Nanosciences and Nanotechnologies: An Action Plan For Europe 2005-2009: Communication from the Commission, to the Council, the European Parliament, and the Economic and Social Committee. June 7, 2005.

[Hhttp://ftp.cordis.europa.eu/pub/nanotechnology/docs/nano\\_action\\_plan2005\\_en.pdf](http://ftp.cordis.europa.eu/pub/nanotechnology/docs/nano_action_plan2005_en.pdf)H

<sup>30</sup> Ishiuzu, 235.

environmental impacts of nanotechnology. Some initiatives by industry and government organizations have attracted criticism as being ineffective, but these codes of ethics, reporting schemes, risk management strategies, and research agendas clearly indicate that the concerns put forward by salient reports, such as those published by Swiss Re and the Royal Society, have had some impact. In this final section, we will summarize the funding of ELSI initiatives in the U.S. the U.K., and the European Union.

### **Public Funding of Nanotechnology ELSI Initiatives**

One way to discover how much attention is being paid to the ethical and societal implications of nanotechnology is to study the amount of funding designated by countries for research into the ethical, legal, and societal implications (ELSI) of this new technology. While collecting data for this survey, we ran across a number of obstacles to getting a good international picture. Along with issues of language barriers and the public availability of documents, different countries describe and count environmental health and safety funding (EHS) and ELSI in different ways. For example, the United States classifies the portion of the budget designated for ELSI programs in two different sections, Environment, Health and Safety, and Education and Societal Dimensions. Other government bodies, such as the European Union, only recently began publishing reports of funding levels for EHS research and related projects, but have not specifically tracked the funding of projects that address other societal implications.<sup>31</sup>

One approach to addressing this issue is to create a publicly accessible database, and invite scholars, scientists, and government agencies around the world to submit reliable data about ELSI funding levels. CSEP has begun designing such a database, and has populated it with data gathered during research for the NEB. The information is accessed through an interactive map where users can click on a country to display the overall known public funding of nanotechnology research and development, the level of ELSI funding, as well as a list of and links to known projects or programs looking at the societal implications of nanotechnology. In the next few months, CSEP will send out an invitation to all known international nanotechnology coordination offices and ELSI projects, inviting them to submit data for inclusion on the web site.

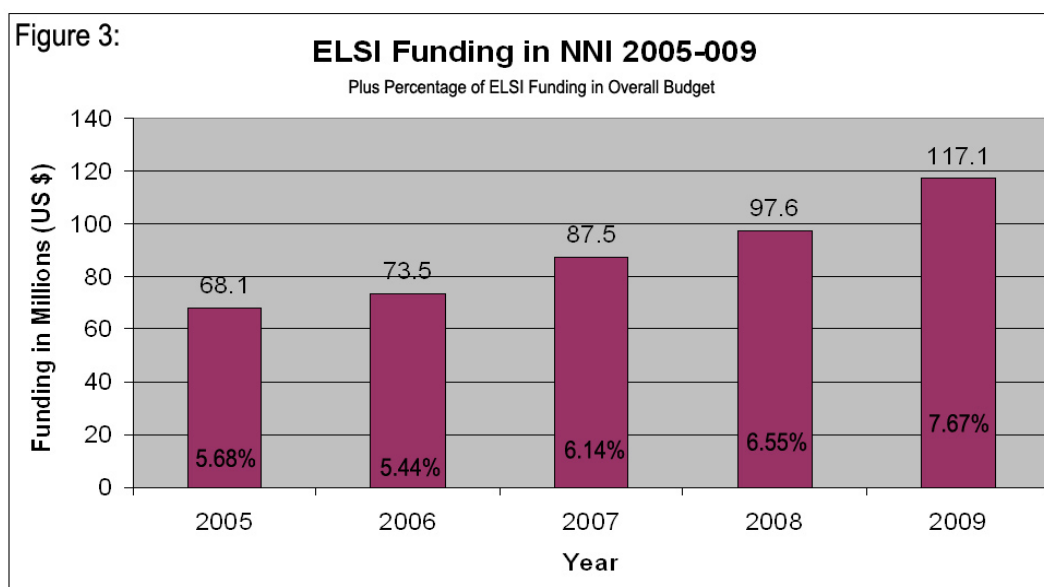
From the data CSEP has gathered, it is clear that the U.S. was the first country to include EHS and ELSI funding in their overall plan for nano development. After the workshop, “Societal Implications of Nanoscience and Nanotechnology” held in September 2000, the National Science

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<sup>31</sup> “National Nanotechnology Initiative FY 2009 Budget and Highlights.” National Nanotechnology Initiative Publications. 2009. [http://www.nano.gov/NNI\\_FY09\\_budget\\_summary.pdf](http://www.nano.gov/NNI_FY09_budget_summary.pdf) p. 2.



Foundation made support for social, ethical and environmental research a priority.<sup>32</sup> According to an article by M.C. Roco, U.S. investment in research with societal and educational implications in FY2003 was estimated at about \$30 million, and research on environmental impacts at about \$50 million. This was approximately 10% of the overall budget for FY 2003.<sup>33</sup> The U.S. NNI budgets only begin to show a breakdown of the overall allocation of funds by area beginning in 2005. From FY2005 to 2006, the percentage of funds dedicated to Human Health and the Environment, and Education and Societal implications dropped slightly, but since FY2006 it has been steadily rising. According to the estimated budget for FY2009, spending on human health and the environment research saw a great increase, from \$58.6 million in 2008, to \$76.4 million in 2009. This count does not include funding for research in the areas of instrument research, metrology and the development of standards, which theoretically should also be counted as a type of societal and ethical implications funding. If this were included the total percentage of ELSI funding for the 2009 budget would be closer to 13% of the overall NNI budget of \$1.527 billion.



The European Union has also been extremely active in funding nanotechnology research, though the percentage of funding dedicated to societal and ethical implications appears to be much smaller. According to the data CSEP obtained, €29.6 million of the total €1.429 billion of nanotechnology funding in the Research Framework Program FP6 (2002-2006) went towards research on the human health and environmental implications of nanotechnology, or about 2% of the total budget. This figure may be misleading, however, as the report this information came from only

<sup>32</sup> Roco, M.C. "Broader Societal Issues of Nanotechnology." *Journal of Nanoparticle Research* 5, 181-189, 2003.P. 186. [Hhttp://www.nsf.gov/crssprgm/nano/reports/BroaderSocIssue.pdf](http://www.nsf.gov/crssprgm/nano/reports/BroaderSocIssue.pdf) H .

<sup>33</sup> Roco., 186.



gathered information about environmental health and safety research, and relied on projects submitting information about their funding levels for inclusion in the report.<sup>34</sup> Along with funding from the FP6 program, member EU countries allocated €47 million to EHS research on nanotechnology during the period 2002-2007. We hope to be able to collect a far richer set of funding data as after we have launched the public version of the ELSI funding database and are able to use this database to collect data from international governments and ELSI project leaders.

## **Conclusion**

A considerable amount of attention has been paid to the possible environmental and health effects of nanotechnology due in part to the pace of scientific and industrial innovation in the nanotechnology field, but also perhaps partially due to salient reports published by government agencies, insurance organizations, scholarly organizations, advocacy groups, and the writings of scholars. The E.U.'s percentage of government funding for EHS research is much lower than the U.S., but countries in Europe have been quicker to begin considering adopting a more precautionary approach to nanotech development, as shown in some of the reports reviewed here. In the U.S, the emphasis seems to be more on ensuring a strong research strategy for studying the potential EHS implications of nanotechnology to help fill in potential gaps in knowledge before taking any major steps towards regulation. Overall, national governments seem to have taken a more wait-and-see approach, concentrating efforts on EHS research, developing standards and best practices for nanotechnology, and using voluntary reporting schemes to begin collecting data about engineered nanoparticles.

In this regulatory vacuum, some industry organizations, advocacy groups, and local governments are leading the attempt to address uncertainty about the potential EHS implications by influencing major players in nanotech R&D to take voluntary measures such as adopting codes of conduct for nano researchers. A much smaller number of organizations such as the Berkeley City Council and the Soil Association have taken a precautionary approach, and have passed mandatory measures as a precautionary approach to nanotechnology, regarding negative effects that may arise. Though there are over 800 different consumer products containing nanomaterials now available for sale, we are still at the very beginning of understanding, much less addressing the potential ethical and

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<sup>34</sup> See European Commission. "EU Nanotechnology R&D in the Field of Health and Environmental Impact of Nanoparticles." January 28, 2008. [H<http://ftp.cordis.europa.eu/pub/nanotechnology/docs/final-version.pdf>](http://ftp.cordis.europa.eu/pub/nanotechnology/docs/final-version.pdf) .

societal implications of nanotechnology research and development.<sup>35</sup> However, with the attention that these potential implications are now receiving, we do seem to be making a very promising start.

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<sup>35</sup> See the Consumer Products Industry, developed and maintained by the Woodrow Wilson International Center for Scholars' Project on Emerging Nanotechnologies. <http://www.nanotechproject.org/inventories/consumer/>.

## Appendix I: Risk Reports

### Government Reports

2001	U.S. National Science and Technology Council,	Societal implications of nanoscience and nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=18;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=18;</a>
2003	U.S. National Science and Technology Council	Nanotechnology: Societal Implications - Maximizing benefits for humanity <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1551;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1551;</a>
2003	U.S. National Nanotechnology Initiative	Nanotechnology and the Environment - Applications and implications <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=358;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=358;</a>
2004	German Future Technologies Division of VDI Technologiezentrum GmbH	Industrial application of nanomaterials: Chances and risks <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1679;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1679;</a>
2004	U.K. Community Health and Consumer Protection	Nanotechnologies: A preliminary risk analysis <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=147;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=147;</a>
2004	David, Mark (U.K. Health and Safety Executive /NIOSH)	Nanomaterials: A risk to health at work? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=224;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=224;</a>
2005	European Commission Scientific Committee on Emerging and Newly Identified Health Risks	The Appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1650;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1650;</a>
2005	E.U. NanoForum	Fourth NanoForum Report: benefits, risks, ethical, legal, and social aspects of nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=101;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=101;</a>
2006	Australian Safety and Compensation Council	A review of the potential occupational health and safety implications of nanotechnology for the department of employment and workplace relations final report <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1810;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1810;</a>
2006	U.K. Food Safety Agency	Draft Report of the Food Safety Agency Regulatory Review <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=355;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=355;</a>
2006	U.S. National Science and Technology Council	Environmental, health, and safety research needs for engineered nanoscale materials <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=252;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=252;</a>
2006	Swiss Eidgenössische Ethikkommission für die Biotechnologie im Ausserhumanbereich	Nanobiotechnologie : Ein ethische Auslegeordnung <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1632;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1632;</a>
2006	Commission de l'ethique de la science et de la technologie (Canadian Science and Technology Ethics Committee)	Ethics and Nanotechnologies: A basis for actions <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1805;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1805;</a>
2006	Umwelt Bundes Amt (German Federal Environment Agency)	Nanotechnology: Opportunities and risks for humans and the environment <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1859;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1859;</a>

2007	U.S. Environmental Protection Agency	Nanotechnology White Paper <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=392">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=392</a> ;
2007	E.U. Health and Consumer Protection Directorate-General Scientific Committee on Consumer Products	Opinion on the Safety of Nanomaterials in Cosmetic Products <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1848">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1848</a> ;
2007	Switzerland BAFU/BAG	Synthetische Nanomaterialien : Risikobeurteilung und Risikomanagement Grundlagenbericht zum Aktionsplan <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1663">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1663</a> ;
2007	E.U. European Group on Ethics in Science and New Technologies to the European Union	Opinion on the Ethical Aspects of Nanomedicine <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1548">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1548</a> ;
2007	U.S. Food and Drug Administration	Nanotechnology: a report of the U.S. Food and Drug Administration Task Force <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1685">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1685</a> ;
2007	Umwelt Bundes Amt (German Federal Environment Agency)	Rechtsgutachten Nano-Technologien – ReNaTe (Legal Appraisals of Nano Technologies) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1655">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1655</a> ;
2008	Büro für Technikfolgen-Abschätzung (Office of Technology Assessment at the German Parliament)	Konvergierende Technologien und Wissenschaften (Converging Technologies) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1995">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1995</a> ;
2008	Cambridge Nanomaterials Advisory Committee/ Cambridge Public Health Department	Recommendations for a Municipal Health and Safety Policy for Nanomaterials: A report to the Cambridge City Manager <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2005">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2005</a> ;
2008	Food Safety Authority of Ireland	The Relevance for Food Safety of Applications of Nanotechnology in the Food And Feed Industries. <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2012">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2012</a> ;
2008	European Food Safety Authority	Draft Opinion of the Scientific Committee on Potential Risks Arising from Nanoscience And Nanotechnologies on Food and Feed Safety <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2081">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2081</a> ;

## NGO Reports

2003	ETC Group	The Big Down: from Genomes to Atoms <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1577">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1577</a> ;
2003	Greenpeace	Future Technologies, Today's Choices <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=85">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=85</a> ;
2003	Wardak, Ahson ; David Rejeski (Woodrow Wilson Project on Emerging Nanotechnologies)	Nanotechnology & Regulation: a case study using the Toxic Substances Control Act (TSCA) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=65">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=65</a> ;
2004	Meridian Institute	International Dialogue on Responsible Research and Development of Nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=233">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=233</a> ;
2004	ETC Group	Down on the Farm: The impact of nano-scale technologies on food and agriculture <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=142">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=142</a> ;
2004	Royal Society ; Royal Academy of Engineering	Nanoscience and nanotechnologies : Opportunities and Uncertainties <a href="http://hum.iit.edu/~csep/NanoEthicsBank/nanoentry.php?bookid=19">http://hum.iit.edu/~csep/NanoEthicsBank/nanoentry.php?bookid=19</a>
2006	Linquiti, Peter ; Adam Teepe (IFCI)	Characterizing the environmental and safety implications of nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=298">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=298</a> ;
2006	Innovation Society	Safety, risk and regulation of engineered nanoparticles : results, trends and perspectives <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1572">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1572</a> ;
2006	American Bar Association	The Adequacy of the Federal Insecticide, Fungicide, and Rodenticide Act to regulate nanotechnology-based pesticides <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=63">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=63</a> ;
2006	Michelson, Evan (Woodrow Wilson Project on Emerging Nanotechnologies)	Nanotechnology Policy: An analysis of transnational governance issues facing the United States and China <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1671">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1671</a> ;
2006	UNESCO	The Ethics and Politics of Nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=353">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=353</a> ;
2006	Friends of the Earth	Nanomaterials, sunscreens, and cosmetics: small ingredients, big risks <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=241">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=241</a> ;
2006	Taylor, Michael (Woodrow Wilson Project on Emerging Nanotechnologies)	Regulating the products of nanotechnology: does the FDA have the tools it needs? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=55">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=55</a> ;
2006	Institute for Food and Agricultural Standards	Nanotechnology Standards: Report of a workshop <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1513">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1513</a> ;
2006	American Bar Association	Environmental Management Systems / Innovative Regulatory Approaches <a href="http://hum.iit.edu/~csep/NanoEthicsBank/nanoentry.php?bookid=62">http://hum.iit.edu/~csep/NanoEthicsBank/nanoentry.php?bookid=62</a>

2006	ETC Group	Nanotech Rx Medical Applications of Nano-scale Technologies: What impact on marginalized communities? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=141">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=141</a> ;
2006	ACONA (For conference)	An Uncertain Business: The technical, social, and commercial risks of nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=141">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=141</a> ;
2007	Woodrow Wilson Project on Emerging Nanotechnologies	EPA and Nanotechnology: Oversight for the 21st Century <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1604">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1604</a> ;
2007	IRGC	Nanotechnology Risk Governance <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=285">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=285</a> ;
2007	Friends of the Earth	Nanosilver: a threat to soil, water, and human health? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1556">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1556</a> ;
2007	Woodrow Wilson Project on Emerging Nanotechnologies	Thinking Big about Things Small: creating an effective oversight system for nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1500">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1500</a> ;
2007	Sass, Jennifer (Natural Resources Defense Council)	Nanotechnology's Invisible Threat: small science, big consequences <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1594">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1594</a> ;
2007	Breggin, Linda K. and John Pendergrass (Woodrow Wilson Project on Emerging Nanotechnologies)	Where Does the Nano Go?: End-of-life regulation of nanotechnologies <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1688">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1688</a> ;
2008	Friends of the Earth	Out of the Laboratory and on to our plates: nanotechnology in food and agriculture <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1855">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1855</a> ;
2008	Taylor, Michael R. (Woodrow Wilson Project on Emerging Nanotechnologies)	Assuring the Safety of Nanomaterials in Food Packaging: The regulatory process and key issues. <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1973">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1973</a> ;
2008	International Council on Nanotechnology	Towards Predicting Nano-Biointeractions: An international assessment of nanotechnology environment, health and safety research needs. <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1906">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1906</a> ;
2008	Felcher, E. Marla (Woodrow Wilson Project on Emerging Nanotechnologies)	The Consumer Products Safety Commission and Nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1998">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1998</a> ;
2008	Luoma, Samuel N. (Woodrow Wilson Project on Emerging Nanotechnologies)	Silver Nanotechnologies and the Environment: Old problems, new challenges? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2010">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2010</a> ;

## Insurance/ Private Industry Reports

2002	Munich Re	Nanotechnology: What is in store for us? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2169">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2169</a> ;
2004	Swiss Re	Small Matter, Many Unknowns <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=20">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=20</a> ;
2005	Allianz/ OECD	Small Sizes that Matter: Opportunities and risks of nanotechnologies <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1515">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1515</a> ;
2006	Innovation Society	Nano-regulation: a multistakeholder Dialogue approach towards a sustainable regulatory framework for nanotechnology <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=105">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=105</a> ;
2006	Lux Research Inc.	Taking Action on nanotech environmental, health and safety risks <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=74">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=74</a> ;
2006	ICF International	Characterizing the Environmental, Health, and Safety Implications of Nanotechnology: Where Should the federal government go from here? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=298">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=298</a> ;
2006	Guy Carpenter & Company Inc. ; Robert Blaunstein	Nanotechnology: The plastics of the 21st century? <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=179">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=179</a> ;
2007	Lloyd's of London	Nanotechnology: recent developments, risks, and opportunities <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1797">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1797</a> ;
2007	Swiss Re	The Risk Governance of Nanotechnology: Recommendations for managing a global issue <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1678">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1678</a> ;

## Appendix II: Nanotechnology Standards

Organization	Title	
ASTM International	E2524-08 Standard Test Method for Analysis of Hemolytic Properties of Nanoparticles <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2170">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2170</a> ;	Approved, 2008
ASTM International	E2525-08 Standard Test Method for Evaluation of the Effect of Nanoparticulate Materials on the Formation of Mouse Granulocyte-Macrophage Colonies <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2172">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2172</a> ;	Approved, 2008
ASTM International	E2526-08 Standard Test Method for Evaluation of Cytotoxicity of Nanoparticulate Materials in Porcine Kidney Cells and Human Hepatocarcinoma Cells	Approved, 2008

	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2173">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2173</a> ; E2578-07 Standard Practice for Calculation of Mean Sizes/Diameters and Standard Deviations of Particle Size Distributions	
ASTM International	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2174">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2174</a> ; E2535-07 Standard Guide for Handling Unbound Engineered Nanoscale Particles in Occupational Settings	Approved, 2007
ASTM International	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1838">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1838</a> ; E-2456-06 Terminology for Nanotechnology	Approved, 2007
ASTM International	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1830">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1830</a> ; WK10417 Standard Practice for the Preparation of Nanomaterial Samples for Characterization	Approved, 2006
ASTM International	WK9952 Standard Practice for Measuring Length and Thickness of Carbon Nanotubes	Under Development
ASTM International	Using Atomic Force Microscopy Methods	Under Development
ASTM International	WK 9327 Standard Practice for Evaluation of Cytotoxicity of Nanoparticulate Materials on Porcine Kidney Cells	Under Development
ASTM International	WK8997 Standard Practice for Analysis of Hemolytic Properties of Nanoparticles	Under Development
ASTM International	WK8051 New Standard Terminology for Nanotechnology	Under Development
ASTM International	WK8705 Measurement of particle size distribution of nanomaterials in suspension by Photon Correlation Spectroscopy	Under Development
	PD 6699-2 Nanotechnologies Par 2 - Guide to safe handling and disposal of manufactured nanoparticles	
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1851">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1851</a> ; PAS 136 : 2007 Terminology for nanomaterials	Approved, 207
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1826">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1826</a> ; PAS 135 : 2007 Terminology for nanofabrication	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1825">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1825</a> ; PAS 134 : 2007 Terminology for carbon nanostructures	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1824">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1824</a> ; PAS 133 : 2007 Terminology for nanoscale measurement and instrumentation	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1823">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1823</a> ; PAS 132 : 2007 Terminology for the bio-nano interface	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1822">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1822</a> ; PAS 131 : 2007 Terminology for medical, health, and personal care applications of nanotechnology	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1821">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1821</a> ;	Approved, 2007
British Standards Institution	PAS 130 : 2007 Guidance on the labeling of manufactured nanoparticles and products containing manufactured nanoparticles	Approved, 2007



	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1820">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1820</a> ; PAS 71 Vocabulary - Nanoparticles	
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1800">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1800</a> ; PD 6699-1 Good practice guide for specifying manufactured nanoparticles	Approved, 2007
British Standards Institution	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1799">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=1799</a> ; ISO/TR 12885:2008 Nanotechnologies - Health and safety practices in occupational settings relevant to nanotechnologies	Approved, 2005
International Standards Organization	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2179">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2179</a> ; ISO/TR 27678:2008 Nanotechnologies - Terminology and definitions for nano-objects – Nanoparticle nanofibre and nanoplate	Approved, 2008
International Standards Organization	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2178">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2178</a> ; ISO/TR 27628:2007 Workplace atmospheres. Ultrafine nanoparticle and nano-structured aerosols. Inhalation exposure characterization and assessment.	Approved, 2008
International Standards Organization	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2177">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2177</a> ; ISO/AWI TS 10797 Nanotubes -- Use of transmission electron microscopy (TEM) in walled carbon nanotubes (SWCNTs)	Approved, 2007
International Standards Organization	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2180">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2180</a> ; ISO/AWI TS 10798 Nanotubes -- Scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDXA) in the characterization of single walled carbon nanotubes (SWCNTs)	Under Development
International Standards Organization	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2181">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2181</a> ; ISO/AWI 10801 Nanotechnologies -- Generation of silver nanoparticles for inhalation toxicity testing	Under Development
International Standards Organization	ISO/AWI 10808 Nanotechnologies -- Monitoring silver nanoparticles in inhalation exposure chambers for inhalation toxicity testing	Under Development
International Standards Organization	ISO/AWI TR 10811 Nanotechnologies - Guide to nanoparticle measurement methods and their limitations	Under Development
International Standards Organization	ISO/NP TS 10812 Nanotechnologies -- Use of Raman spectroscopy in the characterization of single-walled carbon nanotubes (SWCNTs)	Under Development
International Standards Organization	ISO/NP TS 10867 Nanotubes -- Use of NIR-Photoluminescence (NIR-PL) Spectroscopy in the characterization of single-walled carbon nanotubes (SWCNTs)	Under Development
International Standards Organization	ISO/NP TS 10868 Nanotubes - Use of UV-Vis-NIR absorption spectroscopy in the characterization of single-walled carbon nanotubes (SWCNTs)	Under Development
International Standards Organization	ISO/AWI TS 10929 Measurement methods for the characterization of multi-walled carbon nanotubes (MWCNTs)	Under Development
International Standards Organization	ISO/AWI TS 11251 Nanotechnologies -- Use of evolved gas analysis-gas chromatograph mass spectrometry (EGA-GCMS) in the characterization of single-walled carbon	Under Development

	nanotubes (SWCNTs)	
International Standards Organization	ISO/AWI TS 11308 Nanotechnologies -- Use of thermo gravimetric analysis (TGA) in the purity evaluation of single-walled carbon nanotubes (SWCNT)	Under Development
International Standards Organization	ISO/AWI TR 11360 Nanotechnologies -- Outline of nanomaterials classification (Nano tree)	Under Development
International Standards Organization	ISO/AWI TS 11751 Terminology and definitions for carbon nanomaterials	Under Development
International Standards Organization	ISO/AWI TS 11803 Nanotechnologies -- Format for reporting the engineered nanomaterials content of products	Under Development
International Standards Organization	ISO/AWI TR 11808 Nanotechnologies -- Guide to nanoparticle measurement methods and their limitations	Under Development
International Standards Organization	ISO/AWI TR 11811 Nanotechnologies -- Guide to methods for nanobiology measurements	Under Development
International Standards Organization	ISO/NP TS 11888 Determination of mesoscopic shape factors of multiwalled carbon nanotubes (MWCNTs)	Under Development
International Standards Organization	ISO/NP 11931 Nanotechnologies -- Nano-calcium carbonate	Under Development
International Standards Organization	ISO/NP 11937 Nanotechnologies -- Nano-titanium dioxide	Under Development
International Standards Organization	ISO/NP 12025 Nanomaterials -- General framework for determining nanoparticle content in nanomaterials by generation of aerosols	Under Development
International Standards Organization	ISO/NP 12805 Nanomaterials -- Guidance on specifying nanomaterials	Under Development
International Standards Organization	ISO/NP TS 12808 Nanotechnology - Terminology for the bio-nano interface	Under Development
International Standards Organization	ISO/NP TS12843 Nanotechnologies - Terminology for medical, health, and personal care applications	Under Development
International Standards Organization	ISO/NP TS 12901 Nanotechnologies- Guidance on safe handling and disposal of manufactured nanomaterials	Under Development
International Standards Organization	ISO/NP TS 12921 Nanotechnologies - Terminology and definitions for nanostructured materials	Under Development
International Standards Organization	ISO/NP 13013 Nanotechnologies -- Terminology for nanoscale measurement and instrumentation	Under Development
International Standards Organization	ISO/CD 29701 Nanotechnologies - Endotoxin test on nanomaterial samples for in vitro systems	Under Development
International Standards Organization	ISO/NP TS 12144 Nanotechnologies - Core Terms - Terminology and definitions	Under Development
International Standards Organization	ISO/NP 29701 Nanotechnologies -- Endotoxin test on nanomaterial samples for in vitro systems	Under Development
IEEE	IEEE P1690 -- Standard Methods for the Characterization of Carbon Nanotubes Used as Additives in Bulk Materials	Under Development

IEEE	IEEE P1650-2005 -- Test Methods for Measurement of Electrical Properties of Carbon Nanotubes <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2175">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2175</a> ;	Approved, 2005
IEEE	IEEE P1620.2 Standard Methods for the Characterization of Printed and Organic Diode Bridges Structures for RF Devices	Under Development
International Electrotechnical Commission	IEC/TC Nanotechnology Standardization for Electrical and Electronic Products and Systems KSD2711 Measurement of ash content in the carbon nanotube soots – Thermogravimetric analysis	Under Development
Korean Agency for Technology and Standards	KSD2712 Evaluation of Content of Single-Walled Carbon Nanotube using UV-VIS-NIR Absorption Spectroscopy	Under Development
Korean Agency for Technology and Standards	<a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2182">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2182</a> ;	Approved, 2006
Korean Agency for Technology and Standards	KSD2715 Tensile specimen of single- and poly-crystal nano/micro thin film materials <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2183">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2183</a> ;	Approved, 2006
Standardization Administration of China	GB/T 15445.2-2006 Representation of results of particle size analysis—Part 2: Calculation of average particle sizes/diameters and moments from particle size distributions (Published: 2006-02-05; implemented: 2006-08-01) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2184">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2184</a> ;	Approved, 2006
Standardization Administration of China	GB/T 15445.4-2006 Representation of results of particle size analysis—Part 2: Characterization of a classification process (Published: 2006-02-05; implemented: 2006-08-01) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2185">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2185</a> ;	Approved, 2006
Standardization Administration of China	GB/T 20307-2006 General rules for nanometer-scale length measurement by SEM (Published: 2006-07-19; implemented: 2007-02-01) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2186">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2186</a> ;	Approved, 2006
Standardization Administration of China	GB/T 20099-2006 Sample preparation dispersing procedures for powders in liquids (Published: 2006-2-5 implemented: 2006-8-1) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2188">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2188</a> ;	Approved, 2006
Standardization Administration of China	GB/T19627-2005 Particle size analysis - Photon correlation spectroscopy (ISO 13321:1996, IDT) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2189">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2189</a> ;	Approved, 2006
Standardization Administration of China	GB/T19619-2004 Terminology for nanomaterials <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2190">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2190</a> ;	Approved, 2005
Standardization Administration of China	GB/T13221-2004 Nanometer powder - Determination of particle size distribution - Small angle X-ray scattering method (ISO/TS13762, Particle size analysis - Small angle x-ray scattering method, MOD) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2191">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2191</a> ;	Approved, 2004

Standardization Administration of China	GB/T19587-2004 Determination of the specific surface area of solids by gas absorption using the BET method (ISO 9277:1999, NEQ) <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2192;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2192;</a>	Approved, 2004
Standardization Administration of China	GB/T19588-2004 Nano-nickel power <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2193;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2193;</a>	Approved, 2004
Standardization Administration of China	GB/T19589-2004 Nano-zinc oxide <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2194;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2194;</a>	Approved, 2004
Standardization Administration of China	B/T19590-2004 Nano-calcium carbonate <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2195;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2195;</a>	Approved, 2004
Standardization Administration of China	GB/T19591-2004 Nano-titanium dioxide <a href="http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2196;">http://hum.iit.edu/~csep/NanoEthicsBank/detail.php?bookid=2196;</a>	Approved, 2004