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Editor: Barbara D. Beck, Ph.D., DABT

Dr. Beck directs Gradient's nanotechnology, toxicology, and risk assessment practices.

Associate Editor: Chris Long, Sc.D

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Recent Government Briefs

US EPA Consent Order Regarding the Pre-manufacturing Notice of Multi-Walled Carbon Nanotubes

Previously, Nano News reported on one of US EPA's first nanomaterial Pre-Manufacturing Notices (PMNs). Recently, US EPA issued another PMN to a manufacturer of multi-walled carbon nanotubes (MWCNT). Although US EPA determined there was "relatively low potential" for the general population to be exposed to MWCNT, US EPA concluded that MWCNT may present a risk to workers. This consent order, based on the authority of the Toxic Substances Control Act, requires the MWCNT manufacturer to provide MSDS information, submit materials characterization data, maintain certain records, and provide workers with proper protective equipment. Also, it requires the manufacturer to conduct an animal inhalation study which examines bronchoalveolar lavage fluid and which includes an extended post-exposure observation period. This announcement is expected to be published in the Federal Register.

Approaches to Safe Nanotechnology: Managing the Health and Safety Concerns Associated with Engineered Nanomaterials
http://www.ehsnanonews.com/documents/Approaches_to_Safe_Nanotechnology.pdf

By National Institute for Occupational Safety and Health (NIOSH), pre-publication copy

Updating their previous draft report from July 2006, NIOSH produced this final report to provide an overview

of what is known about the potential hazards of nanoparticles and how workplace exposure to nanoparticles can be minimized and monitored. The report analyzed several animal and epidemiologic studies, hypothesizing that effects of inhaled nanoparticles are similar to ultrafine particles with similar characteristics or may be predicted by surface area, composition, and particle number. Noting the potential for chronic respiratory effects such as inflammation and tumor development, and even explosion hazards or unexpected catalytic reactions, NIOSH emphasized that exposure assessment should be conducted for environments where nanomaterials are manufactured or used as part of a manufacturing process. They recommend several methods for measuring and characterizing nanomaterial air concentrations including aerosol sampling, airborne surface area analysis, and particle number measurement. NIOSH noted several challenges for implementation of successful nanoparticle monitoring strategies, including lack of current standards and complexity/uniqueness of individual nanoparticle types. Because health risk information and monitoring strategies are limited at this time, they emphasized minimizing worker exposures through source enclosure, work best practices, use of personal protective equipment, and occupational health surveillance.

Reports, Reviews, White Papers, and Books

An outline scoping study to determine whether high aspect ratio nanoparticles (HARN) should raise the same concerns as do asbestos fibres

By CL Tran, SM Hankin, B Ross, RJ Aitken, AD Jones, K Donaldson, V Stone, and R Tantra; Institute of Occupational Medicine, United Kingdom
http://randd.defra.gov.uk/Document.aspx?Document=CB0406_7760_FRP.pdf

High aspect ratio nanoparticles (HARN) are engineered nanomaterials that have a high length-to-diameter ratio and a large surface area; examples of HARN include nanotubes and nanorods. These particles are similar in size and shape to certain types of asbestos, specifically tremolite and crocidolite. Recently, a consortium of UK scientists completed a study that examined the potential health concerns of HARN using characterization and structure-activity data from asbestos and other industrial fiber studies. Their review identified many similarities between HARN and asbestos; they concluded that there is sufficient evidence to suggest

that HARN have the same characteristics (diameter, length and biopersistence) as asbestos and other industrial fibers. Thus, they concluded that exposure to a sufficient dose of HARN is likely to result in similar pathology. They also noted a knowledge gap in determining human health hazards from HARN. The authors recommended a research strategy that includes further materials characterization, dose-response, and exposure assessment, in order to ascertain the relationship between the HARN physico-chemical properties and their toxicity.

Risk Governance of Nanotechnology Applications in Food and Cosmetics

By Ante Grobe, Ortwin Renn, and Alexander Jaeger; Dialogik Gemeinnuetzige GmbH
http://www.irgc.org/IMG/pdf/IRGC_Report_FINAL_For_Web.pdf

In 2008, the International Risk Governance Council (IRGC) wrote a briefing paper that addressed nanotechnology risk development. The current report by Dialogik substantially revised and updated this original briefing paper. The authors described the use of nanomaterials in agriculture, food processing, food packaging, and nutritional supplements; they summarized research and survey results regarding public opinion and perception; and they reviewed the regulatory background and legal requirements for nanotechnology risk assessment for various governmental regulatory agencies. The report then reviewed general risk assessment studies, focusing on examples from research on synthetic amorphous silica, titanium dioxide, and encapsulated vitamins. After describing several voluntary frameworks that provide guidelines for risk assessment (e.g., the Nano Risk Framework developed by DuPont and Environmental Defense Fund) and suggesting that industry may benefit from using voluntary frameworks (rather than a potentially rigid regulatory process which may have difficulty defining every unique nanomaterial), the authors offer several recommendations - a single comprehensive regulatory code should be developed that can be used worldwide, as opposed to use of a multitude regulatory codes; requirements and standards should be "harmonized" so that performance can be based on a single set of benchmarks; and voluntary codes, if used, should have "teeth" as well as incentives.

Review Of Federal Strategy For Nanotechnology-Related Environmental, Health, And Safety Research

By the Committee for Review of the Federal Strategy to Address Environmental, Health, and Safety Research Needs for Engineered Nanoscale Materials, Committee on Toxicology, National Research Council.

<http://www.nap.edu/catalog/12559.html>

In 2007, the National Research Council (NRC) was asked to independently review the strategy of the National Nanotechnology Initiative's (NNI's) commitment to support

EHS risk assessment and risk management needs with respect to nanomaterials. NRC identified several elements critical to an integral risk research strategy, noting that NNI "does not present a vision, a clear set of goals, a plan of action for how the goals are to be achieved, or mechanisms in place to review and evaluate funded research." NRC notes that while NNI's strategy has potential to communicate the breadth of federal nanotechnology research related to EHS applications, it lacks input from stakeholders, a clear plan regarding how research progress will be measured, and an estimation of resources needed to conduct further research. NRC also expressed concern that the actual amount of federal spending that addresses EHS risks is inadequate and "far less than portrayed [than in NNI's official plan]." They recommended that the NNI identify specific research needs in topics related to EHS (e.g. toxicokinetics, environmental fate, and standardization of testing), continue to foster inter-agency coordination, and identify means of ascertaining progress.

Upcoming Meetings and Conferences

Human & Environmental Exposure Assessment of Nanomaterials Workshop

Bethesda, Maryland, February 24-25

<http://www.nano.gov/html/meetings/exposure/index.html>

This workshop, hosted by the National Nanotechnology Coordination Office (NNCO), will provide a forum for communication among stakeholders about progress in human and environmental exposure research listed in NNI's "Strategy for Nanotechnology-Related Environmental, Health, and Safety (EHS) Research" document (link) . The meeting will discuss the state of the science to identify research needs, data gaps, and emerging trends. The agenda includes presentations on exposure characterization, nanoparticle processes in the workplace environment, and breakout sessions. The presentations, discussions, and comments provided at this meeting will be used to make changes to and expand the National Nanotechnology Initiative's environmental, health, and safety research strategy.

Nanotoxicology: Health & Environmental Impacts

Welwyn Garden City, Hertfordshire, United Kingdom

February 27, 2009, 9am to 5pm

<http://www.regonline.co.uk/builder/site/Default.aspx?eventid=161852>

This event, organized by European Scientific Conferences (EuroSciCon), aims to bring together toxicologists, nanotechnology engineers, industry representatives, and governmental regulatory officials. The one-day symposium will allow nano-scientists to present their current research findings and discuss the potential impact of nanomaterials on human health and the environment. Scheduled presentations cover topics such as health implications of nanoparticles,

the potential hazards of carbon nanotubes, ecotoxicology of nanoparticles, and the effects of silver nanoparticles in the environment.

NanoImpactNet: For a Healthy Environment in a Future with Nanotechnology

Lausanne, Switzerland, March 23-27, 2009

http://www.nanoimpactnet.eu/object_binary/o2841_Handout_NanoImpactNet-Event_Lausanne%202009%20print.pdf

NanoImpactNet, a European network that focuses on the health and environmental impact of nanomaterials, is hosting this platform to exchange ideas about nanotechnology research and to discuss its safe and responsible development. The target audience includes experts and other interested researchers who are developing, testing, or contributing to methods that investigate the health effects and environmental impact of nanomaterials. This three-day conference will include nanotechnology training seminars, workshops, and talks. Topics will include testing strategies, protocols for assessing hazards, environmental dispersion, exposure assessment, life cycle analysis, and nanomaterial standardization.

International Conference on the Environmental Implications and Applications of Nanotechnology

June 9-11, 2009, Amherst, MA (USA)

<http://www.umass.edu/tei/conferences/NanoConference/index.html>

Hosted by the University of Massachusetts Environmental Institute and the US EPA Office of Superfund Remediation and Technology Innovation, this conference will bring together researchers and practitioners to address the environmental implications and application of nanotechnology. The three-day program will include presentations, poster sessions, and an exhibitor hall. Topics to be covered at the conference include materials characterization, green nanotechnology, regulatory issues, environmental fate and transport, toxicology, and pollution control.

California Department of Toxic Substances Control Nanotechnology Symposium Series: "Nanoregulations – Anticipating the Smallest Threats and the Largest Opportunities"

March 19, 2009, Sacramento, California

http://www.dtsc.ca.gov/TechnologyDevelopment/Nanotechnology/index.cfm#DTSC_Nanotechnology_Symposium_Series

The California Department of Toxic Substances Control (DTSC) will host a full-day symposium at California Environmental Protection Agency Headquarters in Sacramento. This event will be free and open to the public, and will also be available

via webcast. The event will focus on the regulatory aspects of nanotechnology, US EPA's role in regulation, and DTSC's chemical information call-in program, which includes nanoscale materials. DTSC's goal is to create a partnership that enhances research and promotes nanotechnology applications and sustainable processes. Speakers include representatives of the California Assembly, the US EPA Nanoscale Materials Stewardship Program, UCLA, and private industry.

Hot-off-the-Presses Peer-Reviewed Research Articles of Note

Peters, T.M., et al. 2009. Airborne monitoring to distinguish engineered nanomaterials from incidental particles for environmental health and safety. *J Occup Environ Hyg* Feb;6(2):73-81.

Abstract: <http://oeh.informaworld.com/soeh/content~content=a906014971~db=all~jumtype=rss>

Synopsis:

- It is well-recognized that one of the principal challenges of nanomaterial exposure assessment involves being able to reliably differentiate engineered nanoparticles from background levels of other ubiquitous nano-sized particles that are a common by-product of any combustion or hot process (e.g., ambient ultrafines, diesel exhaust particulate, welding fumes, cooking emissions). In this article, Peters *et al.* propose two complementary methods for distinguishing airborne engineered nanoparticles from incidental particles, applying their methods in a facility producing nano-structured lithium titanate metal oxide powder.
- Referring to it as "off-line filter-based sampling," the first method proposed by the study investigators relies on collection of traditional filter samples with conventional respirable samplers, and laboratory analysis using transmission electron microscopy (TEM) or scanning electron microscopy (SEM) to distinguish among the different types of collected particles. Describing it as a lower cost alternative to filter-based sampling, Peters *et al.* also propose a second method whereby hand-held, direct-reading, battery-power instruments are used to collect time-series data for multiple measurement metrics (e.g., particle number and mass concentrations). Labeling it "real-time activity-based monitoring," the study authors highlight that these time-series data can be related to releases from specific activities using workplace activity logs.
- Peters *et al.* implemented these two measurement methods in a 60,000-ft² facility where lithium titanate metal oxide nanomaterial, a nanomaterial known for its high surface area and application in fuel cells, is produced. Filter samples were collected in seven locations in the plant, including in close proximity to both the bagging and hopper ends of a rotary calciner, which was identified as a likely source of airborne nanomaterials due to frequent dumping of material from a bucket into the hopper and removal of nanomaterial collection bags. In order to identify lithium titanate nanoparticles, both

TEM and SEM were used to assess particle morphology and composition, while a second set of filters was analyzed for titanium and lithium using inductively coupled plasma atomic emission spectrometry (ICP-AES). In addition, particle number and mass concentrations were measured using two direct-reading instruments, namely a condensation particle counter (TSI 3007 Portable CPC) that measures total number concentration for particles with sizes between 10 nm and 1,000 nm, and an optical particle counter (Grimm PDM-1008) that measures particle number concentrations in 15 distinct size bins for particles ranging in size from 300 nm to 20 μm . Several sources of incidental nano-sized particles were observed to be present, including particles from various welding and grinding operations inside the building, a propane-powered forklift, and outdoor air that entered the building through open overhead doors at the loading dock.

- Filter-based sampling showed the presence of low respirable mass concentrations ($<50 \mu\text{g}/\text{m}^3$) at most locations both inside the facility and outdoors, with ICP-AES indicating low mass titanium concentrations ($<10\%$) and thus little contribution of lithium titanate nanoparticles. Only one area, namely the bagging end of the rotary calciner, had elevated levels of airborne engineered nanoparticles, with respirable mass concentrations of $118 \pm 23 \mu\text{g}/\text{m}^3$ and lithium titanate percentages of $39 \pm 11\%$. Importantly, TEM and SEM analysis of filter samples collected from this area revealed that lithium titanate nanomaterials were not present as free airborne nanoparticles, but were instead present as spherical aggregates (*i.e.*, clusters of fused 10-80 nm nanoparticles) with sizes greater than 200 nm. Real-time activity-based monitoring data confirmed these findings, showing no correlation between very fine ($<300 \text{ nm}$) particle number concentrations and worker activities, but peaks in respirable ($< 4 \mu\text{m}$) and total mass concentrations coinciding with loading of the rotary calciner hopper and changing of the nanomaterial collection bags.
- Based on findings from both of these measurement methods, the study authors concluded that incidental nanoparticles, and not engineered lithium titanate nanomaterials, were the primary source of airborne nano-sized particles inside the facility. They also concluded that airborne engineered nanomaterial in this facility consists primarily of particle aggregates larger than several hundred nanometers.

Implications:

- This study demonstrated how real-time activity based monitoring can provide important information not available from traditional filter-based sampling, namely time-series data that can be correlated with worker activities to identify sources of airborne nanomaterial releases. Microscopic analyses may be impractical for routine assessment of worker exposures due to their high cost, slow turn-around, and the lack of a standardized method for characterizing nanoparticles. Thus, activity-based monitoring offers an alternative, cost-effective approach for identifying sources of airborne nanoparticles and for assessing the movement and

time history of nanoparticles through the workplace. [Note that the NIOSH Approaches to Safe Nanotechnology document summarized above also presents a measurement strategy pairing real-time monitors with filter-based samplers and analysis for nanomaterial exposure assessment.]

- Peters *et al.* illustrate how the combined data of two relatively inexpensive instruments, one which measures particles with sizes ranging from 10 to 1,000 nm and the other which measures particles with sizes ranging from 300 nm to 20 μm , can be used to quantify very fine ($<300 \text{ nm}$) particle number concentrations. Although not a perfect measure of nano-sized ($<100 \text{ nm}$) particles, these instruments offer unique advantages compared to research-grade instruments capable of measuring nanoparticle number concentrations (*e.g.*, the TSI Scanning Mobility Particle Sizer and Fast Mobility Particle Sizer), including reasonable cost, compact size, battery operation, and portability.
- In addition to providing examples of practical methodologies for the measurement of airborne engineered nanoparticles, this paper contributes to the limited data currently available to characterize potential occupational exposures to engineered nanoparticles. This study identified nanomaterial handling activities (*e.g.*, loading of a rotary calciner hopper and changing of the nanomaterial collection bags) as presenting the greatest potential for nanomaterial exposure. These findings also illustrate the tendency of many engineered nanomaterials to be present in air as larger ($<100 \text{ nm}$) particle aggregates rather than as individual nanoparticles.

2. Helfenstein, M; et al. 2008. Effects of combustion-derived ultrafine particles and manufactured nanoparticles on heart cells *in vitro*. *Toxicology*

253:70-78. Abstract: http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCN-4TDCOJ0-1&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=982b63d76f48f7772eabdbaba1ec8e4b

Synopsis:

- There is increasing evidence, from epidemiology, clinical and toxicology studies, that inhalation of ambient particulate matter (PM) may be associated with adverse cardiovascular effects. These effects include cardiovascular morbidity and mortality, alterations in cardiac autonomic function, markers of blood coagulation and systemic inflammation, and changes in vascular reactivity. Recent results from animal toxicology studies demonstrate that acute exposure to combustion-derived ultrafine particles (UFP) can cause adverse cardiovascular effects, which suggests that such particles may play a role in the cardiovascular effects associated with exposure to ambient PM. Adverse cardiovascular effects have also been observed in rats exposed to ultrafine titanium dioxide (TiO_2), providing evidence that ultrafine TiO_2 may be more potent than fine

TiO₂. Studies have also demonstrated that inhaled UFP and nanoparticles (NP) can enter the systemic circulation, reporting their presence in organs throughout the body, including the heart. The aim of the study by Helfenstein and colleagues was to evaluate whether nano-sized particles, including ultrafine diesel exhaust particles (DEP), ultrafine TiO₂, and single-walled carbon nanotube (SWCNT) have direct effects on the heart.

- Cardiac effects of DEP, ultrafine TiO₂ and SWCNT were studied using cultures of neonatal rat ventricular cardiomyocytes (NRVM). NRVM were grown as linear strands of myocytes by culturing cells on glass coverslips patterned with alternating bands of collagen, which promotes cell adhesion, and agar, which inhibits cell adhesion. Cells were exposed for 24 hours to SWCNT, at concentrations of 0.25, 2.5, 25 and 50 µg/mL; to ultrafine DEP, at concentrations of 0.25, 1.25, 12.5 and 125 µg/mL; and to ultrafine anatase TiO₂ (20 – 30 nm mean diameter), at concentrations of 0.0025, 0.025, 0.25 and 2.5 µg/mL. Effects of particle exposure on electrophysiology of NRVM were assessed by measuring nerve conduction velocity (NCV) and maximum action potential upstroke velocity (dV/dt_{max}). Oxidative stress was assessed by measuring generation of reactive oxygen species (ROS), using an intracellular fluorogenic marker. Myofibrillar structure was assessed by laser scanning microscopy, on myocytes stained with fluorescent antibodies for actin and myosin, and also by transmission electron microscopy.
- Among the three particle types evaluated by Helfenstein and colleagues, ultrafine TiO₂ was the most potent for all three endpoints - electrophysiological changes, induction of oxidative stress, and alteration of myofibrillar structure. Ultrafine DEP caused some effects for all three endpoints, but the effects were either less pronounced than, or were observed at much higher particle concentrations, than for TiO₂. SWCNTs had very minimal electrophysiological effects, and had no effect on either oxidative stress or myofibrillar structure. Ultrafine TiO₂ caused a concentration-dependent increase in NCV, with a small, yet significant increase above control at 0.25, and a more pronounced increase at 2.5 µg/L. Ultrafine TiO₂ also caused nominal, yet statistically significant, increases in dV/dt_{max} for concentrations of 0.025 µg/mL and higher. NCV was significantly increased, and dV/dt_{max} significantly decreased, by DEP only at the highest concentration tested, of 125 µg/L. For SWCNT, there was no clear association between exposure concentration and either NCV or dV/dt_{max}. Ultrafine TiO₂ and DEP both induced oxidative stress, as indicated by increased generation of ROS, which was increased in a concentration-dependent manner for both TiO₂ and DEP, with the greatest intensity at the highest concentration tested (2.5 µg/mL for TiO₂, and 125 µg/mL for DEP). SWCNT did not appear to induce oxidative stress, as these particles had no effect on ROS generation up to the highest concentration tested (25 µg/mL). As opposed to untreated cardiac myocytes, for which the myofibrils were well organized, myofibrils in NRVM treated with ultrafine TiO₂, at either 0.25 or 2.5 µg/L, were less organized, although some well-organized myofibrils were

still observed. Myofibrils in NRVM treated with 125 µg/mL DEP were disorganized, while myofibrillar structure of NRVM treated with 25 µg/mL SWCNT was well maintained.

Implications:

- This is the first study to evaluate effects of nano-sized particles (NSP) on electrophysiology and myofibrillar structure of cardiac myocytes. Results from this study indicate that NSP differ with respect to potency, and that effects on electrophysiology and myofibrillar structure may be related to oxidative stress. Effects of NSP on electrophysiology and myofibrillar structure may be related to cardiac effects observed *in vivo*, such as reduced heartbeat in rats instilled with residual oil fly ash.
- Although this study clearly demonstrated that both ultrafine TiO₂ and DEP can affect electrophysiology and myofibrillar structure *in vitro*, and it is possible that these particles could hence have effects on overall cardiac function *in vivo*, the relationship between these *in vitro* effects and overall cardiac function *in vivo* is not clear. For example, it is not known whether the relatively small electrophysiological changes observed in this study would translate into adverse cardiac effects *in vivo*, such as increased or decreased heart rate, heart rate variability, or contractility.
- In addition to potential *in vitro-in vivo* differences in response to particle exposure, the *in vitro* exposure pattern used in this study is very different from an *in vivo* exposure pattern. For one – whereas exposure of cardiac myocytes to NSP occurred under static conditions under which particles could have prolonged contact with the myocytes, exposure of cardiac myocytes to NSP *in vivo* would occur under dynamic conditions, under which the particles would be flowing past actively beating myocytes. Another potential difference is how the exposure concentrations used in this *in vivo* study would compare to blood concentrations for individuals exposed to NSP via inhalation, ingestion or dermal exposure. Replication of these findings in whole animals will help in the interpretation of the toxicological significance of the observed changes *in vitro*.

Guest Contributor

By James Boles, Esq.

Recent EPA Actions Suggest a Continued, Cautious Approach to Nanotechnology

Many anticipate a more aggressive US EPA manifesting not long after President Obama's new EPA Administrator is confirmed. However, the Agency's recent actions on nanotechnology do not suggest precipitous, near-term action. EPA's recent nanotechnology Significant New Use Rules ("SNURs"), its nanotube consent order, and its Nanoscale Materials Stewardship Program ("NMSP") all describe a deliberate Agency that will continue to carefully collect hazard and risk management data. As EPA recently suggested, any near or mid-term regulatory action will likely remain focused on this data collection goal.

The Agency has been explicit regarding its intention to collect data on nanotechnology hazards. In a July 2007 notice announcing a NMSP meeting, EPA stated that "[t]he NMSP will complement and support EPA's new and existing chemical programs under TSCA and will help provide a firmer scientific foundation for regulatory decisions by encouraging the development of key scientific information and appropriate risk management practices for nanoscale chemical substances...." In its January 2008 follow-up, EPA stated that it would use NMSP data "to aid in determining how and whether certain nanoscale materials...present risks....[and] for...building new assessment methods and models or incorporating the data into existing models with regard to hazard, exposure and fate."

The Agency's recent actions on nanotechnology are consistent with those aims. In November 2008, EPA announced SNURs for 56 substances. Two nanomaterials – siloxane modified silica and alumina – were included due to Agency concerns regarding "lung effects" or potential "systemic effects from inhalation and dermal exposure...." EPA determined that use of those nanomaterials without an adequately protective respirator (*i.e.*, one with an Assigned Protection Factor of at least 10) or impervious gloves could cause "serious health effects." Rather than impose provisions for additional exposure restriction and a battery of testing requirements, the Agency concluded that "a 90-day inhalation toxicity test ... would help characterize the human health effects of the [nanomaterial]."

The Agency's consent order with Swan Chemical Company was similarly focused. While it expected chemical absorption of multi-walled carbon nanotubes to be poor by all routes, EPA expressed concern regarding lung irritation resulting from particle respiration. After completing its review, the Agency concluded that "the information available...is insufficient to permit a reasoned evaluation of the human health effects of the... substance." The Agency required that Swan perform a 90-day inhalation toxicity study by a specified confidential production point and employ impervious dermal protection and respirators with a minimum 50 Assigned Protection Factor (APF).

Finally, the Agency's January 12, 2009 interim report has confirmed the continuation of US EPA's deliberate data collection efforts. Prominently cited amongst the Agency report's conclusions were its testing and reporting authorities. Although EPA stated it "will take any necessary action to prevent unreasonable risks", it acknowledged "the Agency has not yet identified any ... submission" requiring such action. Given the Agency suggestion of possible data collection by rule, any near-term, broad TSCA restrictions on nanomaterial manufacture, processing, and use seem remote – even with new, possibly more aggressive political management.

James Boles is a senior associate in the Environmental Practice Group of Howrey LLP. Before becoming an attorney, Mr. Boles spent five years in EPA's Office of Pollution Prevention and Toxics in Washington D.C., where he specialized in TSCA-related issues. Mr. Boles can be contacted at Howrey LLP, 1299 Pennsylvania Ave NW, Washington, DC 20004. Email: BolesJ@howrey.com.

Publication Staff

Editorial

Barbara D. Beck, Ph.D., DABT
Todd C. Hudson, M.S.P.H
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Christopher M. Long, Sc.D.
Mara Seeley, Ph.D., DABT

Production

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Contact Us

Gradient Corporation
20 University Rd
Cambridge, MA 02138
t: 617.395.5000
f: 617.395.5001

email: ehsnanonews@gradientcorp.com
website: www.gradientcorp.com

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