



Overview of the DOE Nanoscale Science Research Centers “Approach to Nanoscale Safety” Guidance Document

**American Chemical Society Meeting
*Safety in Nanotechnology Research***

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Lawrence Berkeley National Laboratory**

Five Department of Energy Nanoscale Science Research Centers



Center for Nanoscale Materials
Argonne National Laboratory



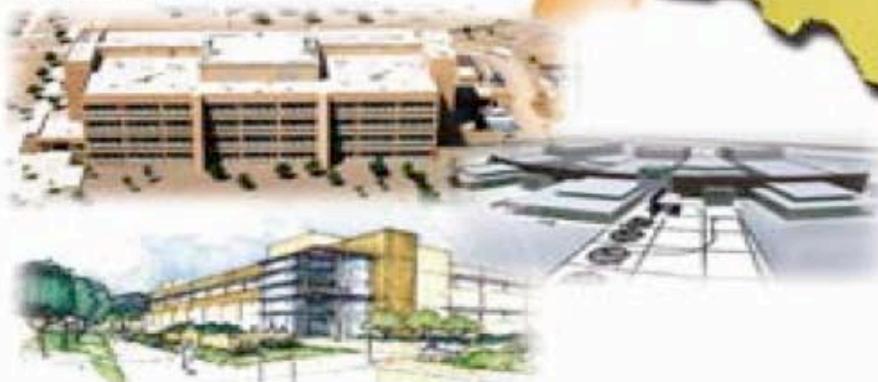
Molecular Foundry
Lawrence Berkeley National Laboratory



Center for Functional Nanomaterials
Brookhaven National Laboratory



**Center for Integrated
Nanotechnologies**
Sandia National Laboratories and
Los Alamos National Laboratory



Center for Nanophase Materials Sciences
Oak Ridge National Laboratory

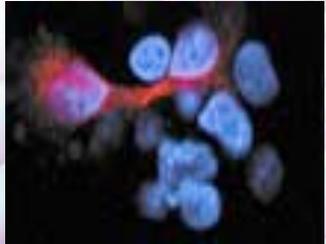




Molecular FOUNDRY
A NANOSTRUCTURES USER LABORATORY

THE MOLECULAR FOUNDRY

**Nanoscale Science Research
Center and User Facility**



Potential for Novel Toxicity



- **Properties of nanoscale materials may be fundamentally different from bulk materials of same composition**
- **Among the new properties of nanoscale materials may be:**
 - **New toxicological properties not seen in bulk material**



Goals of The NSRC Document



1. Prevent exposure to nanomaterials
2. Detect early signs & symptoms of illness
3. Avoid environmental or community impact
4. Respond to perceived hazards
5. Control our own destiny

Current version is revision 2 dated June, 2007

Available at

http://orise.orau.gov/ihos/Nanotechnology/nanotech_OSHrisks.html

Or from Rick Kelly at rjkelly@lbl.gov

Lack of Guidance



- No EPA, OSHA, CPSC, DOT or state regulations
- No national / international consensus standards
- No exposure limits
- No established sampling or analytical methods
- Very limited toxicology, reactivity and environmental data
- MSDSs are often not useful or misleading

The [NSRC Guidelines](#) were developed to fill this void in the short term. The Guidelines may be modified or retired as consensus standards or regulations are published

Contents

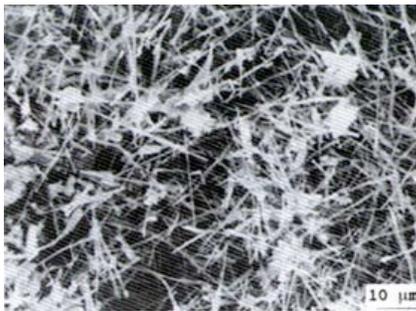


- **Introduction**
- **Conceptual Foundations**
- **Controls for R&D Laboratory Operations**
- **Verifying Program Effectiveness**
- **Transportation of Nanomaterials**
- **Management of Nanomaterial-Bearing Waste Streams**
- **Management of Nanomaterial Spills**
- **Example Industrial Hygiene Sampling Protocol**

Purpose and Limitations



- Provide guidance to the five NSRCs for the development of safety controls
 - Not intended to be adopted verbatim
 - Offer guidance for working with materials of unknown hazard
- Promote consistency among the five nanocenters
- Does not preempt national, state or local regulations



Referenced Documents



- **“Prudent Practices for Handling Hazardous Chemicals in Laboratories”**
 - Treat *“all new compounds, or those of unknown toxicity, as through they could be acutely toxic in the short run and chronically toxic in the long run”*
- **“NIOSH Current Intelligence Bulletin for TiO₂”**
 - NIOSH is concerned about the potential carcinogenicity of insoluble nanoparticulate
- **“DOE Secretarial Policy 456.1 on Nanoscale Safety”**

Work Planning

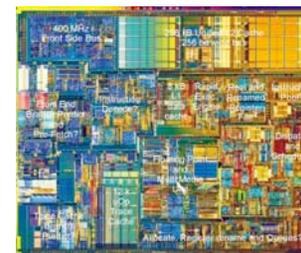


- **Review all work with nanomaterials for EH&S concerns following an established safety-assessment process**
 - **Develop a well defined description of the work**
 - **Involve appropriate subject matter experts**
 - **Industrial hygiene**
 - **Fire protection (for reactive materials)**
 - **Waste management**
 - **Engineered, administrative and personal protective controls**
 - **Consider hazards of precursors and equipment**
 - **Consider potential hazard of nanomaterials captured on filters**

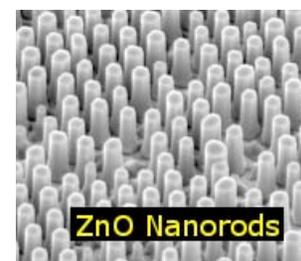
Hazard Banding



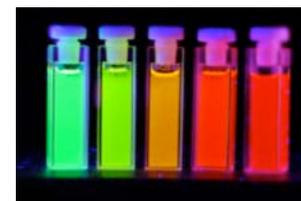
1. Solid materials with imbedded nanostructures



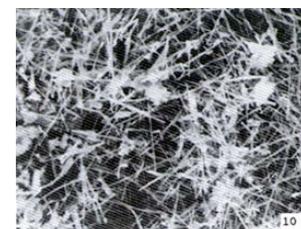
2. Solid nanomaterials fixed to a surface



3. Nanoparticles suspended in liquids



4. Free, dry dispersible nanoparticles



Engineered Controls



- **Work that could generate an aerosol should be conducted in a enclosed, ventilated system such as fume hood, glove box or glove bag**
 - **Alternatively, use close capture system**
 - **Filter/scrub exhaust air where nanoparticles may be generated**
 - **Do not recirculate exhaust air if possible**
 - **Avoid HEPA filtered stand alone hoods or biosafety cabinets if not exhausted to the outside**
 - **NEVER use laminar flow hoods (clean benches)**
- **Test and maintain these systems**



Administrative Controls



- **Develop and implement a chemical hygiene plan specific to the scope of activities**
- **Housekeeping**
 - Clean surfaces after each shift if contaminated**
 - **Consider reactivity of material when selecting method**
 - **Dedicated HEPA Vacuum**
 - **Wet wiping**
- **Work practices**
 - Keep materials in closed containers except when inside ventilated systems**
 - Minimize potential for aerosol and skin contact**
 - Use PPE when engineered controls not used**

Posting and Labeling



- Post signs at entrance to work area warning of nanomaterials
- Label storage containers



COMMENTS:

Dispersible nanoscale materials may be handled in this lab



Building 67 Rooms 1201



MINIMUM REQUIRED PERSONAL PROTECTIVE EQUIPMENT:

Eye protection required within delineated area surrounding fume hood
Carry eye protection at all times in other parts of lab

APPLICABLE FORMAL WORK AUTHORIZATION DOCUMENTS:

None

COMMENTS:

RESPONSIBLE INDIVIDUALS:

Name	Location	Work Phone #	Work Cell #	Home Phone #
Frank Ogletree	67-1210	(510) 486-4862	(510) 305-7908	(510) 528-3502
Virginia Alton	67-1212	(510) 486-5173		(510) 559-7814
Miguel Salinas	67-2111	(510) 486-6704	(510) 234-3212	

BUILDING AND FACILITY MANAGER:

Name	Location	Work Phone #	Work Cell #	Home Phone #
Gil Torres	62-104A	(510) 486-5395	(510) 289-5137	(925) 756-7255
Rick Kelly	67-3205	(510) 486-4088	(510) 457-8452	(510) 537-8391

Personal Protective Equipment



- **Wear PPE when failure of a single control could entail significant risk of exposure**
 - Alternately, equip engineered controls with performance monitors
- **Typical wet chemistry PPE when needed**
 - Closed toe, low permeability shoes
 - Long pants without cuffs
 - Gauntlet gloves or gloves with sleeve extenders
 - Lab coats (consider notifying vendor)
 - Eye protection
- **Respirators should be half mask P100 if used**



Monitoring and Characterization



- Minimally, use direct reading instrument to measure airborne nanoparticle level
- Perform more sophisticated air sampling
 - Recommended methods provided in appendix A
 - TSI 3007 Nanoparticle counter
 - GRIMM particle size analyzer
 - Filter collection with EM analysis
 - Other alternatives
 - Size selective nanoparticle counters
 - Surface area counters

TSI 3007



TSI surface area meter



GRIMM Sizer

Worker Competency



- **Identify people potentially exposed to nanoparticles**
 - Registry
- **Provide appropriate nanosafety training**
 - Also training for chemicals, PPE, waste, etc
- **Provide awareness-level training to guests (users)**
- **Provide written procedural requirements to guests**



Medical Exams



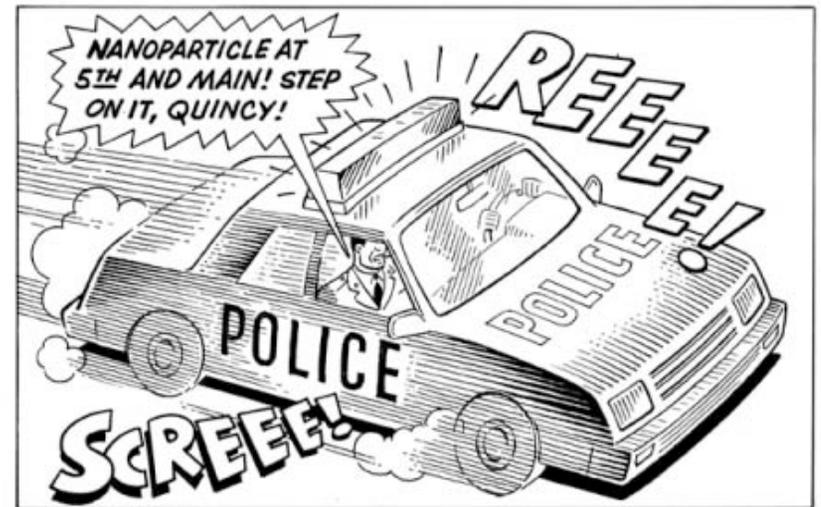
- **Provide workers with “baseline” medical evaluations and nonspecific routine health monitoring program**
 - Worker**
 - works with nanoparticles & may inhale them or get them on their skin, or
 - spends significant time in area where dispersible nanoparticle are handled, or
 - works on potentially contaminated equipment
- **Provide immediate exam for people exposed in an “incident”**
- **Exempts non-resident people**
 - Guests, users**



Transportation of Nanomaterials



- If classified as hazardous per 49 CFR must be packaged, marked and shipped per these regulations
 - If shipped by air, must meet International Civil Aviation Organization requirements
- If suspected to be hazardous, follow step above
- If not hazardous per usual standards, still package in DOT PG 1 container
 - Sealed container inner, absorbent, exterior container

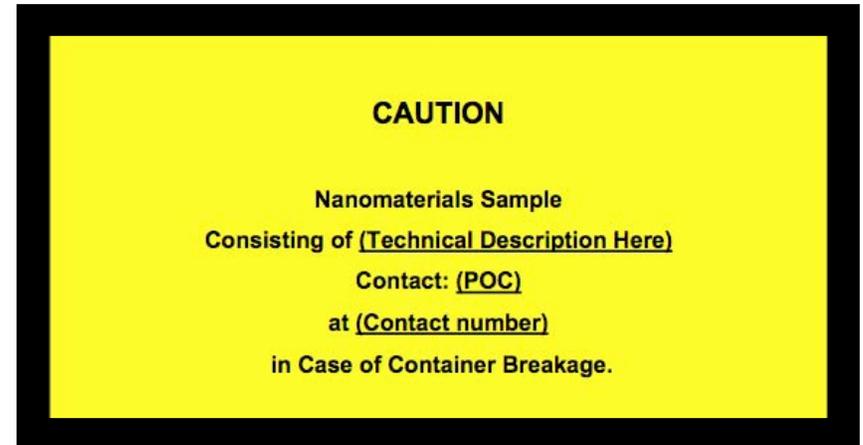


<http://www.nanotechbuzz.com/50226711/comic.jpg>

Transportation of Nanomaterials



- **Label**
 - Label nanomaterial sample containers
 - Powder: “Nanoparticles can exhibit unusual reactivity and toxicity. Avoid breathing dust ingestion or skin contact”
- Provide an MSDS or equivalent information compiled by researcher
- For on-site transfer
 - Follow the sites usual chemical transport policy, or
 - Follow DOT rules



Waste Management



- If classified as hazardous per 40 CFR or state regulations, dispose of waste using standard hazardous waste procedures
- If not classified as hazardous, send the waste to a RCRA permitted TSDF anyway
 - Include instruction on how to dispose of material
- Do not permit nanomaterials to be shipped to researchers home institution for disposal

Waste Management



- **Applicability**
 - Pure nanomaterials
 - Items contaminated with nanomaterials
 - PPE, glassware, wipes, rinse water
 - Liquid suspensions containing nanomaterials
 - Solid matrices with friable nanomaterials attached to surface
 - Does not apply to fully imbedded nanomaterials



Spills



- **Small spills cleaned up by lab personnel**
- **Large spills cleaned up by hazmat team**
- **Refer any people exposed in the incident for a medical review**
- **Clean up spill using wet methods/HEPA vacuuming**
- **Treat all clean up equipment as “contaminated”**
- **Dispose of waste appropriately**



Questions?

