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30 Aug 11

From: Officer In Charge, Naval Medical Administrative Unit,
Monterey
To: Chairman, Physics Department, 833 Dyer Road, Naval
Postgraduate School, Monterey CA 93943
Subj: ANNUAL INDUSTRIAL HYGIENE SURVEY, PHYSICS DEPARTMENT,
NAVAL POSTGRADUATE SCHOOL, MONTEREY
Ref: (a) OPNAVINST 5100.23G, Chapter 8
Encl: (1) Industrial Hygiene Survey Report 66271-11-5

1. Per reference (a), an annual industrial hygiene survey of the Physics Department, Naval Postgraduate School, Monterey was conducted by the Naval Medical Administrative Unit (NMAU), Monterey Industrial Hygienist from 2 to 18 August 2011.

2. Both action items **involve the medical surveillance program. The Rail Gun Electronics Technician needs to be scheduled for a termination Noise medical surveillance exam based on his recommended removal from the NPS Hearing Conservation Program, and the departmental Machinist/Model Maker needs to be scheduled as soon as possible for both Noise and Metal Working Fluids medical surveillance exams. Please inform the Industrial Hygienist of the status of these actions by 1 November 2011.**

3. If there are any changes in operations, please complete Appendix L and forward it to the NMAU Industrial Hygienist. If further consultation on this report is needed, please contact S. Eric Thurston at Commercial (831) 656-2477, email at sethurst@nps.edu.

S. E. Thurston
S. E. THURSTON
By direction

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2011 Industrial Hygiene Survey
of
Physics Department
Naval Postgraduate School, Monterey
Report 62271-11-5
2 to 18 August 2011

Survey Conducted by: S. Eric Thurston,
Industrial Hygienist

Survey Reviewed and Approved by: Michael J. Puckett, MPH, REHS
Supervisory Industrial
Hygienist

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EXECUTIVE SUMMARY

1. The 2011 annual industrial hygiene survey of the Physics Department, Naval Postgraduate School, Monterey was recently conducted to assess the occupational health portion of the department's NAVOSH Program.

2. The organization of the report is as follows:

- Departmental Space Designations
- Discussion, Findings and Recommendations
- IH Exposure Assessment/Monitoring Plans, Appendix A
- Historical Air Sampling Results, Appendix B
- Air Sampling Results, Rail Gun Firing, Appendix C
- Measured Equipment Noise Levels, Appendix D
- Field Noise Survey Forms, Appendix E
- Sketch Of Measured Noise Levels, Augmented Rail Gun Firing, Appendix F
- Local Exhaust Ventilation Systems Evaluation, Appendix G
- Respiratory Protection Program Matrix, Appendix H
- Medical Surveillance Program Matrix, Appendix I
- Training Matrix, Appendix J
- Standardized IH Glossary, Appendix K
- Change of Operation Notification Form, Appendix L

3. There were two formal Findings associated with this survey report, both involving the occupational health medical surveillance program:

- Since his noise exposures is much less than in the past, the Rail Gun Electronics Technician can be removed from the NPS Hearing Conservation Program, and **he needs to be scheduled for a termination audiogram (hearing test) at the Presidio of Monterey, Army Medical Clinic, Occupational Health Department.** If his future duties result in a significant 8-hour time-weighted average (TWA) noise exposure potential, he can always be re-entered into the program at that time.
- Although recommended in the past several Physics Department annual industrial hygiene survey reports, the departmental Machinist/Model Maker reports that he has not received the required annual audiogram (hearing test) for many years. He needs to be scheduled for both the Noise and Metal Working Fluids medical surveillance exams as soon as possible.

EXECUTIVE SUMMARY (continued)

Other items of special note are as follows:

- **Lab Manager Kerry Yarber's excellent coordination of the department's Occupational Safety and Health Program is recognized.**
- **Jay Adef, the departmental hazmat program coordinator is to be commended on administering an excellent program, which serves as a role model.**
- This survey included a baseline survey of the Free Electron Laser Laboratory; there were no Findings or Recommendations for the portion of the survey covering this lab.

4. Overall, the occupational health portion of the department's NAVOSH Program is **Excellent**.

**2011 SURVEY SPACE DESIGNATIONS
FOR PHYSICS DEPARTMENT ROOMS**

SPANAGEL HALL, BUILDING 232, by room number

2 Sensors Research Lab	29 PH/PW Shared Welding Room
3E/F Explosive Simulations Lab	35 Rail Gun Machine Shop/ Wood Shop
4 Student Study Area	
5 Laser Development Teaching Lab	36 Acoustics Lab
6 Raman Lab	37 Electromagnetic Rail Gun
8A Directed Energy Simulation	37B Rail Gun Machine Shop
8 Acoustics Computer Lab	38 Machine Shop
11 PhD student area	42 Seismo/Sonar Transducers
13 Remote Sensing Lab	44 FEL Prep Lab
15 Physical Acoustics Lab	105 Computer Lab
16 Electronics Assembly Area	107A,B,C,D Acoustics Lab
17/23 Advanced Acoustics Lab	111 Autonomous Surface/Land Vhcls
18 Simulations Lab	121-124 Computer Stations
19/21 Anechoic Chambers	125A,B,C/127 Basic Physics Lab
20/22 Remote Sensing Lab	133 Scanning Electron Microscope
24 Scanning Electron Microscope	135 Optics, Sensors Teaching Lab
25 Underwater Acoustics	139B Optics Storeroom
26 Optical Microscope	141 Educational Physics Lab
27 Gas Gun Research Lab	148 Electronics/Applied Physics

WATKINS HALL, BUILDING 245

1XX NanoMEMS Air Scrubbers Outdoor Shed (non-operational)
 1XX NanoMEMS Compressed Gas Closet
 1XX NanoMEMS Compressor
 213 NanoMEMS Clean Room Support Space (Prep Room)
 214 NanoMEMS Clean Rooms (1,000 and 10,000 levels)

(New) Bldg 230

Free Electron Laser (FEL) Lab

Room reassignments since the 2010 survey are as follows:

- Room 4 is now a student area, and the plans for setup of a new research lab did not materialize.
- Room 6 is now the new Raman Lab.
- Room 11 is now a PhD student area and no longer houses Plasma Physics.
- Room 13 now houses the Remote Sensing Lab rather than the Space Physics Computer Lab.
- The Scanning Electron Microscope has been moved from Room 26 into Room 24, with this microscope lab replacing the Electro Optics Lab formerly located there.
- Room 26 now houses an Optical Microscope Lab.

PROGRAMS REVIEW

References: (a) OPNAVINST 5100.23G
(b) TLVs and BEIs, Threshold Limit Values For
Chemical Substances and Physical Agents, Biological Exposure
Indices, ACGIH

As required by Chapter 8 of reference (a), an annual industrial hygiene of the Physics Department, Naval Postgraduate School, Monterey was conducted from 2 to 18 August 2011. The primary purpose of this survey was to identify and assess exposure to occupational hazards, review the occupational health portion of the NAVOSH program, and update the Exposure Monitoring Plan (EMP).

A. ENGINEERING CONTROLS: Engineering controls used in this department to reduce exposures include:

- use of temperature-controlled soldering irons to minimize the generation of airborne lead and other metal fumes
- Fume Eliminator machine used by the department's Machinist/Model Maker when welding in the adjacent shared Welding Room 29
- two electronically-controlled laboratory hoods are present in the Watkins Hall, Room 214 Clean Room to exhaust chemical vapors generated during processes performed here
- optical cable used to shield the class IV laser in the Room 27 Gas Gun Research Lab, reducing it to class I status
- enclosure of one of the class IV lasers in the Rooms 5 Laser Development Teaching Lab and the class IV laser in the Room 27 Gas Gun Research Lab, and double enclosure of the class IIIb laser in the Room 6 Raman Lab, again reducing them to class I status
- placement of the Electromagnetic Rail Gun inside an enclosed wooden structure to reduce noise exposures

B. RESPIRATORY PROTECTION PROGRAM (RPP): Operations requiring the use of respirators are not performed in this department, and personnel do not wear them on an elective basis.

C. HAZARDOUS MATERIAL CONTROL AND MANAGEMENT PROGRAM (HMCM): A spot check of spaces reviewed indicate that hazardous material inventory lists have been developed, and Material Safety Data Sheets (MSDSs) were available for chemical products stored and used. Each product has been assigned a unique number for cross-referencing between the inventory list and its MSDS. The Free Electron Laser (FEL) Lab recently started operations, and this lab's program, including development of an inventory list and consolidation of MSDS's, is in the process of being established there. **Jay Adeff, the departmental hazmat program coordinator is to be commended on administering an excellent program, which serves as a role model.**

D. HEARING CONSERVATION PROGRAM (HCP): The only 8-hour TWA noise exposure in this department that exceeds the Navy Noise Occupation Exposure Limit (NOEL) is limited to the departmental Machinist/Model Maker's use of machine tools. He wears ear muffs during operation of this equipment. As such, he needs to continue enrollment in the NPS Hearing Conservation Program (involving annual training and annual audiograms (hearing tests)).

As noted in the discussion of the Medical Surveillance Program section of this report, the Rail Gun Lab Electronics Technician's current noise exposure is much less than in the past, and he no longer requires entry in the Hearing Conservation Program. However, he needs to continue use of hearing protection during use of the cutoff saw, Shop Vac drum vacuum, and compressed air nozzle present in the Room 35 Wood Shop. The same is true for personnel present during firing of the rail guns in the Room 37 Rail Gun Lab, where either ear plugs but mostly muffs are worn during this process.

Appendix F of this report is a sketch of the noise levels measured during a firing of the augmented rail gun that occurred after the issue of the previous survey report; the special survey report issued as a result of these measurements advised Lab personnel of the boundaries of the noise hazard radii, inside of which personnel need to wear hearing protection. Personnel whose noise exposure is limited to that involving firing of the rail guns do not require entry into the NPS Hearing Conservation Program.

FEL Lab personnel wear either disposable ear plugs or ear muffs when within the noise hazard radius of the portable air compressors, and their use needs to continue during operation of this equipment. They likewise do not require entry into the NPS Hearing Conservation Program.

E. PERSONAL PROTECTIVE EQUIPMENT (PPE): The following PPE is worn for protection against potential health hazards associated with the listed processes:

PPE	PROCESS/PURPOSE
Laser goggles	Operation of free space class IV laser in the Room 5 Laser Development Teaching Lab
Ear muffs or disposable ear plugs	During Rail Gun firing or operation of Rail Gun Machine Shop/Wood Shop machine tools or vacuums
Ear muffs	Machinist/Model Maker operation of machine tools
Welding helmet and leather gloves	Machinist/Model Maker performing oxy-acetylene, MIG, or TIG welding
Latex or nitrile rubber exam gloves	Chemical product handling by a variety of departmental personnel
Ear muffs or disposable ear plugs	Portable air compressors operation at the FEL Lab
Faceshield and thermal gloves	FEL Lab personnel handling liquid nitrogen or helium

All PPE were found to be clean, serviceable, and properly stored. Personnel using PPE require completion of training on a one-time basis as outlined in Appendix J of this report and as required by Chapter 20, Section 2013 of reference (a).

F. NON-IONIZING RADIATION CONTROL PROGRAM: The sources of non-ionizing radiation in this department include the following:

- Electromagnetic Rail Gun in the Spanagel Hall Room 37 Rail Gun Lab
- Spanagel Hall Room 5 Laser Development/Teaching Lab: enclosed class IIIb laser, and free space and enclosed class IV lasers
- Spanagel Hall Room 6 Raman Lab: doubly enclosed class IIIb laser
- Spanagel Hall Room 27 Gas Gun Research Lab: class IV laser (shielded with optical cable)

Electro-Magnetic Field (EMF) radiation exposure above the TLVs during firing of the Rail Guns is unlikely based on extremely brief exposure, where they are only fired once or twice per day in less than one second bursts. The previous NPS Radiation Safety Officer (RASO) indicated that an exposure calculation cannot be made since the extremely short burst prevents the 6-minute averaging time needed for the calculation as cited in reference (b).

F. NON-IONIZING RADIATION CONTROL PROGRAM (continued):

The optical cable shielding for the class IV laser in Room 27 reduces it to class I status, which does not pose a hazard. Single or double enclosures of the class IIIb and IV lasers in Rooms 5, 6, and 27 also reduce their status to class I. Laser radiation exposure above the TLVs during operation of the free space class IV laser in Room 5 is unlikely because proper laser goggles are worn and proper administrative control procedures, such as use of posted warning signs and a flashing yellow light outside the room, are being followed as documented in departmental SOPs. Initial laser training is provided to both staff and students, but the students graduate before annual refresher courses would be necessary. All class IIIb and IV lasers are under the control of the NPS Laser Systems Safety Officer (LSSO) and Assistant LSSO. No laser-related injuries have occurred since the previous industrial hygiene survey.

G. OCCUPATIONAL REPRODUCTIVE HAZARDS PROGRAM (ORHP):

Per reference (a), Chapter 29, reproductive hazards identified during the survey include:

- lead during minimal lead-tin soldering conducted throughout departmental spaces
- lead during handling of the lead bricks stored in the Spanagel Hall basement Storage Room
- toluene present in Scotchkote Electrical Coating used in several Spanagel Hall rooms and in the black aerosol paint in the Spanagel Hall Room 37 Rail Gun Lab
- use of alcohols for chemical cleaning in several rooms and labs in Spanagel Hall
- methanol present in Flux-Off soldering flux remover used in the Room 2A Sensors Research lab
- isopropyl alcohol present in LPC CFC Free Electro Contact Cleaner used by the departmental Machinist/Model Maker
- isopropyl alcohol present in the Novahol Cleaner/Detergent used in the Watkins Room 214 Clean Room
- isopropyl and ethyl alcohols used for chemical cleaning and degreasing at the FEL Lab
- xylenes present in the Shipcoat Primer used in the Spanagel Hall Room 27 Gas Gun Research Lab
- toluene and xylenes present in the black aerosol paints used for touchup painting of robots in the Room 111 Autonomous Surface and Land Vehicles Lab, as well as in the rubber coating used at the FEL Lab
- noise during operation of a variety of equipment throughout the department

G. OCCUPATIONAL REPRODUCTIVE HAZARDS PROGRAM (ORHP)
(continued): Lead is a hazard to both males and females, and also presents a hazard to a developing fetus. Toluene and exposure to significant noise levels are hazards to a developing fetus, while alcohols and xylenes present a female reproductive hazard. As discussed in Appendix A, the exposure assessment section of this report, significant exposures to the above chemicals and noise are not expected.

H. MEDICAL SURVEILLANCE PROGRAM (MSP): Refer to Appendix I for the Medical Surveillance Program Matrix for guidance in program enrollment of departmental personnel based on industrial hygiene assessments. Note that enrollment in additional surveillance programs to comply with safety requirements may be prescribed separately by the NPS Safety and Occupational Health Office.

FINDING 62271-11-5-1: The Rail Gun Lab Electronics Technician uses the Room 35 Wood Shop machine tools, compressed air nozzle, and drum vacuum much less than in the past, especially since construction of the wooden enclosure built around the rail gun bench setup has been completed. The current assessment indicates that his 8-hour TWA exposure is below the NOEL, and therefore his enrollment in the NPS Hearing Conservation Program is no longer necessary.

RECOMMENDATION 62271-11-5-1: The Rail Gun Lab Electronics Technician no longer requires annual audiograms (hearing tests) or annual hearing conservation training. He should be scheduled for a termination audiogram with the Occupational Health Department of the Presidio of Monterey, Army Medical Clinic. If his future duties result in a significant noise exposure assessment, he can always be re-entered into the program at that time.

FINDING 62271-11-5-2: The Machinist/Model Maker reports that he has not received an annual audiogram (hearing test) as required by Chapter 18, paragraphs 1806a and b of reference (a); his enrollment in both the Noise and Metal Working Fluids medical surveillance programs has been outlined in the Medical Surveillance Matrix portions of the past several departmental industrial hygiene survey reports.

RECOMMENDATION 62271-11-5-2: Schedule the Machinist/Model Maker for an audiogram and also for the Metal Working Fluids occupational health medical exam as soon as possible with the Occupational Health Department of the Presidio of Monterey, Army Medical Clinic as outlined in Appendix I of this report.

I. OCCUPATIONAL HEALTH-RELATED TRAINING MATRIX: See Appendix J for the Training Matrix based on occupational health-related assessments conducted by the Industrial Hygienist. Additional training for safety-related hazards or based on other requirements may be identified separately by the NPS Safety and Occupational Health Office, or as automatically prescribed by the Enterprise Safety and Application Management System (ESAMS) when the user logs onto his or her account.

J. ERGONOMICS: Repetitive tasks are not performed in this department.

APPENDIX A

IH EXPOSURE ASSESSMENT/MONITORING PLAN		
WORKPLACE INFORMATION		
Organization: Naval Postgraduate School	Dept: Physics	Work Center: General Laboratories
Location: Bldg 232	Lab Manager: Kerry Yarber	Phone: 831-656-3886
Workers: 17 staff/faculty with potential exposure to occ health hazards, # and sex of students vary	Male: 15 staff/faculty with potential exposure to occ health hazards	Female: 2 faculty with potential exposure to occ health hazards
<p>Operations: Laboratories are used for course demonstrations and individual student or staff research. Intermittent, short duration *lead-tin soldering, both with and without soldering flux is performed in many rooms. The most common chemicals stored and used in the <u>laboratory spaces</u> are acetone, *methanol, and *ethanol, but a variety of other low toxicity chemical products are also present and used in very small amounts.</p> <p><u>Room 000</u> is currently under the control of the NPS Radiation Safety Officer, who has restricted access to the room because of the presence of radioactive sources stored there. Chemical product containers formerly stored in this room were removed and excessed.</p> <p><u>Room 2A</u> (formerly 002/003C) <u>Sensors Research Lab</u> performs work associated with MEMS and nanoMEMS sensors. *Ethyl alcohol (ethyl alcohol) and *methanol, as well as a variety of other low toxicity chemical products and greases, are used here. Flux-Off, containing *methanol, is used for removal of excess solder from previously soldered items. A class II laser is new to this lab since the previous survey, but it inherently does not pose a hazard since the blink mechanism of the eye provides adequate protection against ocular damage. Also new to this lab is an optical microscope, and a wire bonding system, which uses small wire to make miniature circuit boards, much like a miniature wire feed welding setup. The metal bonding process takes place within an enclosed portion of the system. There are 3 faculty and 2 to 3 students per quarter performing work in this lab.</p> <p><u>Room 5</u> (formerly 003/005) <u>Laser Development Teaching Lab.</u> An enclosed class IV laser (downgraded to class I because of its enclosure) and class II lasers, as well as a class IIIb laser new to this lab since the previous survey but currently non-operational, are present in the general lab space. Also new since the previous survey is a separate room which now houses the class IV free space laser; the flashing yellow light is now mounted above the door of the new room, and the same laser caution sign continues to be posted on the door. There is one staff member and one or two faculty members during any academic quarter working in this lab.</p>		
<p>* = Reproductive Hazard</p>		

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION (continued)

Organization: Naval Postgraduate School	Dept: Physics	Work Center: General Laboratories
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Operations (continued): Room 6 (formerly 006) houses the new Raman Lab. This lab contains a Raman spectrometer whose operation is supported by a class IIIb laser, which is downgraded to class I status by its double enclosure. *Lead-tin soldering occurs here, and ethyl alcohol and acetone are used for general chemical cleaning. Large compressed gas cylinders containing mixtures of both helium and argon gases are used during the spectrometer's operation. There is one faculty member and four or five students currently performing work in this new lab.

Room 15 (formerly 015) Physical Acoustics Lab and Room 16 (formerly 016) Electronics Assembly Area: a variety of *alcohols and low toxicity chemical products are used here, and *lead-tin soldering with a soldering gun also occurs.

Rooms 24 (formerly 024) Scanning Electron Microscope Lab There are two scanning electron microscopes present, but no chemicals are used in this lab and there are no hazardous noise sources located here.

Room 26 (formerly 026) formerly housed a Scanning Electron Microscope, but it was moved into Room 24 since the previous survey. This room is now the Optical Microscope Lab with one such microscope present. A laminar flow hood is present, as well as a non-operational Automatic Ball Bonder system acquired from a company external to NPS; this system is similar to the wire bonding system in Room 2A.

Room 27 (formerly 027) houses the Gas Gun Research Lab. Helium is placed under high pressure in a small cylinder and shot into a vacuum chamber, where shock waves travel down the barrel for testing done on a variety of products, including ceramics, plastic, and metals. All personnel in the room are present on the other side of the wall from the gun barrel when the helium is fired. A class IV laser shielded by use of optical cable (and therefore reduced to class I status) is present inside the chamber. *Lead-tin soldering is also performed here. There is only one person, a faculty member, working in this lab who is qualified to operate the laser. Several primers and paints, one of which contains 1% *xylenes, are applied with brushes to the gun barrel for touchup purposes.

Basement Storage Room houses numerous storage racks of a variety of items, as well as a yellow flammable storage locker that contains chemicals used in other labs. Stored in front of this locker are several *lead bricks, currently not used for any purpose but retained in case they are needed in the future.

*** = Reproductive Hazard**

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION (continued)

Organization: Naval Postgraduate School	Dept: Physics	Work Center: General Laboratories
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Operations (continued): Room 42 (formerly 042) Seismo-Lab/Sonar Transducer Lab: several different chemical products are currently stored here, but they were used during previous projects and experiments. There is nothing of industrial hygiene interest in this location.

Room 44 (formerly 044) FEL Prep Lab is used for mechanical setup of equipment for use and operation at the Free Electron Laser (FEL) Lab, and for setups that are to be tested where vacuums can be established inside the equipment without leakage.

Rooms 107 and 107 A,B,C, and D Acoustics Labs: several small acoustics rooms are present but are currently used for storage only. *Isopropyl and *ethyl rubbing alcohols and a variety of low toxicity chemical products are used here, and *lead-tin soldering is also performed.

Room 111 Advanced Electronics: *lead-tin soldering occurs here, and a Robots Lab is present in this room. A Black and Decker electric hand drill is used for small-scale and brief duration drilling of aluminum and plastic. Black aerosol paint cans containing both *toluene and *xylenes are used for rare and brief touchup painting of robots.

Room 133 Advanced Materials and Devices Lab: There is one scanning electron microscope present in a separate side room, and *isopropyl alcohol, *methanol, and acetone are used here for chemical cleaning. *Lead-tin soldering is performed in this room, and liquid helium is used in the sample preparation process.

Class IIIa and IIIb lasers are being stored but not used in the Room 135 Optics and Sensors Teaching Lab. This lab also used class II lasers for classroom demonstrations.

*Lead-tin soldering occurs in the Room 148 Electronics/Applied Physics Teaching Lab.

The following rooms house processes involving computer use only and have no industrial hygiene interest: Room 3 E/F (formerly 003E/003F) Explosives Simulation Lab, Room 8A (formerly 008A) Directed Energy And Electric Weapons Simulation Lab, Room 8 (formerly 008B) Acoustic Computer Lab, Room 13 (formerly 013) Remote Sensing (Space Physics) Computer Lab, Room 18 (formerly 018) Radar Imaging Computer Simulations-Inverse Scatter Lab, Rooms 20 and 22 (formerly 020 and 022) Space Physics Computer Lab, Room 105 Computer Lab, Room 210 Computer Research Lab, and Room 223 Computer Electronics Prep Room.

* = Reproductive Hazard

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION (continued)

Organization: Naval Postgraduate School	Dept: Physics	Work Center: General Laboratories
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Operations (continued): The following rooms house processes which (do not solely involve use of computers but) likewise have no industrial hygiene interest: Room 11 (formerly 011) Remote Sensing Lab, Rooms 17/23 (formerly 017/023) Advanced Acoustics Lab/Underwater Acoustics Tank, Rooms 19/21 (formerly 019/021) Anechoic Chambers, Room 25 (formerly 025) Underwater Acoustics, Rooms 125 A,B,C,D/127 Basic Physics Lab, and Room 610 Storage/Staging Room.

WORK TASK	POTENTIAL HAZARD	WORKERS INVOLVD	FREQUENCY/DURATION	MONITORING RECOMMENDED?
Chemical compnds	Chemicals	15	30 mins/month	No-see EA Chem
Soldering	*Pb,Sn,ZnCl fumes	17	10 mins/month	No-see EA Chem
Class IV lasers	Laser radiation	10	<10 mins/day	No-see EA Phys
Class IIIb lasr	Laser radiation	9	<10 mins/day	No-see EA Phys
Rm 111HandDrill	*Noise	3	Biwklly, 2 mins	No-see EA Nse

IH EXPOSURE ASSESSMENT (EA)

NOISE: The calculated 8 hr TWA noise exposure during use of the Room 111 Black and Decker 3/8 Inch Electric Hand Drill will not exceed the NOEL based on its measured noise level and brief duration of use. The measured noise levels of the two types of hand-held heat guns present in several rooms are far below the Navy criterion level of 84 dBA.

PHYSICAL AGENTS: The blink mechanism of the eye will preclude significant ocular exposure during operation of the class II laser located in Room 2A.

- The Room 5 free space class IV laser radiation levels are not expected to exceed the TLVs based on following laser safety requirements (SOPs, controls, and PPE (laser goggles)).
- The enclosure for the class IV laser in Room 5 effectively downgrade them to class I status, which does not pose a hazard.
- Use of laser goggles and interlocks on the laser room door of Room 5, as well as following proper control procedures outlined in SOPs during use of the free space class IV laser will preclude significant ocular exposure to laser radiation.
- The class IIIb laser in Room 6 is downgraded to class I status by its double enclosure.
- The optical cable used in conjunction with the class IV laser in Room 27 effectively downgrades it to class I status.
- Skin contact with extreme cold during handling of flasks containing liquid helium in Room 133 is prevented through use of thermal gloves.

* = reproductive hazard

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION (continued)

Organization: Naval Postgraduate School	Dept: Physics	Work Center: General Laboratories
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IH EXPOSURE ASSESSMENT (EA)(continued)

CHEMICALS: Exposures to chemical compounds, including acetone, *methanol, *ethanol, *isopropyl alcohol, *toluene, *xylenes, and other low toxicity solvents and chemicals, are unlikely to exceed the MSLS and PELs based on intermittent, brief duration and minimal small-scale usage.

-*Lead, tin, and zinc chloride exposures during soldering and concurrent use of soldering flux are unlikely to exceed the MSALS based on monitoring data of similar operations performed elsewhere and brief duration of exposure, and use of-temperature-controlled soldering irons (which limit generation of lead fumes).

PERSONAL PROTECTIVE EQUIPMENT (PPE): Laser goggles during use of the class IV free space laser discussed above.

-Thermal gloves during handling of flasks containing liquid helium in the Room 133 Advanced Materials and Devices Lab.

ENGINEERING CONTROLS: Temperature-controlled soldering irons.

-Optical cable used to shield the class IV laser in the Room 27 Gas Gun Research Lab, reducing it to class I status.

-Enclosure of the class IV lasers in the Rooms 5 Laser Development Teaching Lab and Room 27 Gas Gun Research Lab, and double enclosure of the class IIIb laser in the Room 6 Raman Lab, all of which downgrade the lasers to class I status, which does not pose a hazard.

RESPIRATORY PROTECTION: Not required and not worn on elective basis during departmental operations.

*** = reproductive hazard**

MONITORING PLAN

POTENTIAL HAZARD	NUMBER OF MEASUREMNTS	METHOD OF MEASUREMNT	METHOD OF MEASUREMNT	FREQUENCY (per year)	MAN-HOURS (per year)
None		1	2		

Use the following codes: not applicable.

Signature: Signed/ S. Eric Thurston, Industrial Hygienist	Date: 11 August 2011
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IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School	Dept: Physics	Work Center: Electro-magnetic Rail Gun Lab/ Machine Shop, Wood Shop
Location: Bldg 232, Rooms 35, 37 & 37B	Supervisor: Prof William Maier	Phone: 831-656-2250
Workers: 5-7 + 1 contractor	Male: 2 permanent, # and sex of students vary	Female: 0 permanent, # and sex of students vary

Operations: Two models (augmented and monolithic) of Electromagnetic Rail Guns are fired for research in the Room 037 Rail Gun Lab involving one staff member, one contractor, one professor, and typically 2-4 students per quarter.

The Rail Gun assembly is set up inside a large wooden enclosure in the Room 37 (formerly 037) Rail Gun Lab for protection against accidental projectiles that might be created during the process and to reduce personnel exposure to noise generated when the gun is fired. An exhaust duct leading to a fan set up by lab personnel outside the room's window is attached to the top of the wood enclosure to vent metal fumes and other chemical vapors/gases outside after the gun is fired.

Tin-silver solder and Kester Chlor-A Solder Flux are used here, and 70% *isopropyl (rubbing) alcohol and acetone are rarely used in very small amounts for general cleaning of equipment.

There is a small Rail Gun Machine Shop in the adjacent Room 37B (formerly 048) used to machine aluminum and copper items used for the rail gun with a low rpm, metal-cutting band saw. The combination milling/drilling machine stopped working since the previous survey, and was excessed out rather than repaired. Any milling or drilling to be done is now performed by the departmental Machinist/Model Maker located in Room 38.

The Room 35 (formerly 035) Wood Shop currently contains a cutoff saw set up on a wheeled cart, a lathe, a Bridgeport milling machine, a compressed air nozzle, and a Shop Vac drum vacuum for wood dust cleanup. The rest of the machine tools formerly located in this room in the past have been removed. The remaining equipment is used much less than in the past since the wooden enclosure for the rail gun has been completed.

*** = Reproductive Hazard**

WORK TASK	POTENTIAL HAZARD	WORKERS INVOLVD	FREQUENCY/DURATION	MONITORING RECOMMENDED?
Fire rail guns	*Noise, EMF, Mtl Fume	6	<1 second/day	No-EA Nse, Phys
Soldering	Sn, Ag, ZnCL fumes	1	10 mins/month	No-see EA Chem
Chemical clean	Acetone, *Isop alc	1	30 mins/month	No-see EA Chem
Band saw	*Noise, Al, Cu dust	1	15-20 mins/wk	No-EA Nse, Chem
Wood Work/Vac	*Noise, Wood dust	1	5mins/day max	No-EA Nse, Chem

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION

Organization: Naval Postgraduate School	Dept: Physics	Work Center: Electromagnetic Rail Gun Lab/Machine Shop, Wood Shop
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IH EXPOSURE ASSESSMENT (EA)

NOISE: Measured impact noise levels during firing of the rail guns are below the Navy noise criterion level of 140 dB. Measurements collected during firing of the rail guns indicates instantaneous noise levels can exceed the Navy criterion level, but the calculated 8-hour TWA continuous noise exposures are far below the NOEL of 84 dBA.

-The measured noise level of the band saw in Room 37B is below the Navy criterion level of 84 dBA.

-The calculated combined 8-hr TWA noise exposure from use of the cutoff saw, compressed air nozzle, and Shop Vac drum vacuum for a total of 5 minutes per day maximum is far below the NOEL.

-The measured noise levels of the same models of the lathe and milling machine present in other NPS departments are below the Navy noise criterion level of 84 dBA.

PHYSICAL AGENTS: EMF radiation exposure above the TLVs during firing of the rail gun is unlikely based on extremely brief exposure and because of the distance personnel are located from the source (rail gun) during its firing.

CHEMICALS: Tin (Sn), silver (Ag), and zinc chloride (ZnCl) fume exposures during soldering are unlikely to exceed the MSALs and OELs based on monitoring data of similar lead-tin soldering operations performed elsewhere and brief duration of exposure, and use of temperature-controlled soldering irons (which limit generation of metal fumes).

-Exposures to acetone and *isopropyl alcohol are unlikely to exceed the MSLs and PELs based on intermittent, brief duration and minimal usage.

PERSONAL PROTECTIVE EQUIPMENT (PPE): Ear plugs or muffs during rail gun firing, and during use of machine tools.

-Latex exam gloves during handling of chemical products.

RESPIRATORY PROTECTION: Not required and not worn on an elective basis during operations listed above.

ENGINEERING CONTROLS: Temperature-controlled soldering irons.

-A local exhaust fan with grille is mounted in the ceiling of the wood enclosure containing the Rail Gun as described above.

* = reproductive hazard

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION

Organization: Naval Postgraduate School	Dept: Physics	Work Center: Electromagnetic Rail Gun Lab/Machine Shop, Wood Shop
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MONITORING PLAN

POTENTIAL HAZARD	NUMBER OF MEASUREMNTS	METHOD OF MEASUREMENT 1	METHOD OF MEASUREMENT 2	FREQUENCY (per year)	MAN-HOURS (per year)
None					

Use the following codes: not applicable.

Signature: Signed/ S. Eric Thurston, Industrial Hygienist	Date: 4 August 2011
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IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey	Dept: Physics	Work Center: Physics Machine Shop
Location: Bldg 232, Rooms 29 and 38	Lab Manager: Kerry Yarber, Survey POC: George Jaksha	Phone: 831-656-2304
Workers: 1	Male: 1	Female: 0

Operations: The departmental Machinist/Model Maker manufactures items needed by students and staff for research using metal, PVC, wood stock, and machine tools.

Room 38 (formerly 038) Machine Shop: Aluminum is the primary metal worked on, but can also include stainless steel, brass, or copper stock, and includes occasional machining of PVC. 1 milling machine, 1 CNC milling machine, 2 lathes, 2 dual bench grinding wheels, 1 band saw, 1 drill press, and 1 cutoff saw (power hacksaw) are present.

-A thin sheet of +beryllium stock can be snipped using hand shears, but this has only occurred once in the past 20 years, and not in the past year.

-Performs low rpm cutting of *lead plates using the band saw, but this has not occurred in the past 9 years.

-PVC parts are attached by first brushing PVC Primer onto parts using the brush attached to the bottle lid, followed by brushing PVC Cement in the same manner.

-Gluing acrylic parts together using a small syringe and either 100% +methylene chloride, or TAP Plastics Free-Flowing Acrylic Cement (present in a 1-gallon metal can) or Weld-On #16 Clear Thickened Cement for Acrylic Sheet (both of which also contain +methylene chloride). The one tube of Weld-On Cement is almost completely empty. A very small amount of kerosene is used to aid in the removal of the paper backing from the acrylic sheets. This type of work was not performed since the previous survey.

-Performs minimal, brief duration silver soldering about 10 times in the past year. The silver solder used does not contain cadmium. Very occasional (lead-free) tin-antimony soldering is also performed.

-Uses small amounts of *ethyl alcohol or acetone to remove machine oil from machined parts.

-Uses Dykem blue layout and staining fluids, and Dykem Dyklean dye remover and thinner to remove these fluids once parts are machined.

-Waterproofs electrical connections of machine parts using Scotchkote Electrical Coating applied with a brush that is attached to the can lid.

-Occasionally uses aerosol cans of black enamel to paint metal parts.

-Less than 1 ounce of LPS CFC-Free Electro Contact Cleaner per time is used to clean machined threads.

*** = reproductive hazard + = carcinogen**

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey **Dept:** Physics **Work Center:** Physics Machine Shop

Operations (continued): Public Works Welding Room 29 (formerly 029): The Machinist/Model Maker performs brief duration oxy-acetylene (OA) welding on aluminum or brass, MIG welding on steel alloys, and rare TIG welding on stainless steel or aluminum. OA and TIG welding was not performed in the past 2 years, and MIG welding was performed about 5 times in the past year for about 5 minutes per time.

Room 35 (formerly 035) Wood Shop: The departmental Machinist/Model Maker uses the cutoff saw and the Shop Vac drum vacuum in the Room 35 Rail Gun Machine Shop/Wood Shop for occasional work on plywood and pine stock.

WORK TASK	POTENTIAL HAZARD	WORKERS INVOLVD	FREQUENCY/DURATION	MONITORING RECOMMENDED?
PVC Chem Cmpnds	Solvents	1	2 ounces/time	No-see EA Chem
Acrl cmnt,+MeCl	+Methln chl rde	1	10 mins/time	No-see EA Chem
Soldering	Metal fumes	1	Annual, 5 mins	No-see EA Chem
Chemical clean	Solvents	1	< 6 ozs/year	No-see EA Chem
Dykem fluids	*Alcohols	1	< 6 ozs/year	No-see EA Chem
Scotchkote Coat	*Toluene,solvs	1	2 ounces/year	No-see EA Chem
Aerosol paint	Solvents	1	2 ounces/year	No-see EA Chem
LPS Cleaner	*Isoprpl alchl	1	< 1 ounce/time	No-see EA Chem
Welding	Metal fumes	1	Monthly, 15 mins	No-see EA Chem
Table saw,vacm	Wd dust,*Noise	1	1x/mo, 1 hour	No-EA Chem,Nse
Machine Shop tools	MtlDust,OMist,*Lead, *Noise	1	Up to 8 hrs/day	No-EA Chem, Yes-EA Noise

IH EXPOSURE ASSESSMENT (EA)

NOISE: The calculated 8-hour TWA *noise exposure from use of the cutoff saw, Shop Vac drum vacuum, and use of the Machine Shop machine tools is expected to exceed the NOEL based on measured noise levels and 8-hour exposure.

PERSONAL PROTECTIVE EQUIPMENT (PPE): Ear muffs during operation of machine tools. Welding helmet with self-adjusting lens and leather gloves during welding operations.

RESPIRATORY PROTECTION PROGRAM: Operations performed do not require use of respirators and are not worn.

ENGINEERING CONTROLS: Airflow Mini-Pac portable air cleaning exhaust ventilation unit (Fume Eliminator Machine) during welding.

* = reproductive hazard + = carcinogen

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION (continued)

Organization: Naval Postgraduate School, Monterey	Dept: Physics	Work Center: Physics Machine Shop
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IH EXPOSURE ASSESSMENT (EA)(continued)

CHEMICALS: -*Ethanol, acetone, Stoddard Solvent, *alcohols, other solvent and oil mist exposures during chemical cleaning, and use of Dykem fluids, aerosol paint cans, PVC chemical compounds, and machining oils are unlikely to exceed the MSALs and OELs based on minimal usage.

-Wood dust exposure is unlikely to exceed the MSAL and OEL based on extremely brief duration duration.

-Monitoring data collected during use of acrylic cement or +methylene chloride both in this shop and in the machine shops of 2 other NPS departments indicates +methylene chloride exposure is far below the AL, PEL-TWA, and STEL.

-Rare, brief duration usage of cadmium-free silver solder and (lead-free) tin-antimony solder will not result in metal fume exposures above the MSALs and OELs.

-*Toluene exposure above the MSAL and OELs will not occur based on minimal usage and method of application of Scotchkote Electrical Coating.

-*Isopropyl alcohol exposure during use of LPS CFC Free Electro Contact Cleaner is not expected to exceed the MSAL and OELs based on minimal and brief usage.

-Metal fume exposure will not exceed the OELs and MSALs based on brief duration welding operations and use of a Fume Eliminator Machine.

-Metal dust exposure during use of Machine Shop machine tools are unlikely to exceed the MSALs and OELs based on the nature of intermittent, extremely small scale jobs.

-*Lead exposure above the AL and PEL will not result from very rare, very low rpm, brief duration metal cutting operations.

-+Beryllium exposure is unlikely to exceed the MSAL and OEL based on method of cutting (hand shears), where dust is not created; beryllium in this case mainly presents an ulcer hazard if imbedded in the skin.

*** = reproductive hazard + = carcinogen**

POTENTIAL HAZARD	NUMBER OF MEASUREMENTS	METHOD OF MEASUREMENT 1	METHOD OF MEASUREMENT 2	FREQUENCY (per year)	MAN-HOURS (per year)
None					

Use the following codes: not applicable

Signature: Signed/ S. Eric Thurston, Industrial Hygienist	Date: 8 August 2011
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IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey	Dept: Physics	Work Center: NanoMEMS Rooms
Location: Bldg 245, Rooms 1XX, 213, 214	Lab Manager: Kerry Yarber	Phone: 831-656-2304
Workers: 8-12 (combination of faculty, staff, students-no more than 4 in Clean Rooms at a time)	Male: Varies by class	Female: Varies by class

Operations: The 1XX NanoMEMS Air Scrubber Water Processing Shed is not being currently used since processes necessitating its use are not currently being performed. An outdoor metal shed contains one 50-gallon plastic tub of sulfuric acid and one 50-gallon plastic tub of sodium hydroxide. Water will be pumped down from the rooftop air scrubbing system to the interior of this shed, where it will be treated with the acid and hydroxide. The plastic tubs are placed on plastic mats with expandable bladders to containerize any spills; the tubs are expected to be changed out manually about every 2 years. SOPs including use of neoprene rubber gloves and aprons, faceshields, and chemical safety goggles, during handling of the tubs will be developed and posted when the shed becomes operational. A barrel-handling dolly will be used to move the tubs to avoid ergonomic hazards and injuries. A chemical spill kit locker will be attached to the exterior of the shed when it is operational.

The 1XX NanoMEMS Compressed Gas Room has no room number, but it is located just outside the Bldg 245 door that is located just west of the Processing Shed. Compressed cylinders of nitrogen and argon are chained to one side of the wall with piping going up to the Clean Room where the gases are used. The other side has compressed cylinders of methane, ethylene, and hydrogen with piping going up to the Clean Room to feed into the Nanotool oven. Excessive flammable gases in the Clean Room would automatically be flooded by the compressed nitrogen to avoid spread of a fire. The compressed argon is used in one of the nanotool processes in the Clean Room.

The Rooms 213/214 Prep and Clean Rooms include a "10,000 level" space and a "1,000 level" space. 3 male faculty members and currently 3 male students perform work in these spaces.

*** = reproductive hazard**

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION

Organization: Naval Postgraduate School	Dept: Physics	Work Center: NanoMEMS Rooms
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Operations (continued):

10,000 space:

- A very small solvent cleaning and stripping station is set up inside one of the electronically-controlled laboratory fume hoods; there are several sinks in the base of the hood into which nano parts can be dipped in for chemical cleaning or coating purposes. Currently no chemicals are present or used, but eventually acetone, isopropyl alcohol, and several photo-resistant developer chemicals will be applied to parts.
- A second identical fume hood will contain very small amounts of various acids when it is fully operational. Currently only hydrofluoric acid that is part of a silicon dioxide film etching is approved for use, but there has been no need as of yet to perform any process using this type of acid.
- After removal from the second hood, the parts are then moved into the Final Cleaning Device, which contains Heat Transfer Fluid HC-50 and pressurized gas, and finally placed inside a small pressurized oven vented with forced air exhaust to "dry" the parts that are worked on.
- Navahol, a special chemical product that contains *isopropyl alcohol and comes in wipe and liquid form, and Novaclean Detergent, that contains no hazardous ingredients, are used to clean the rooms. An optical table is present, and will be used for one of the nanotool processes.

1,000 space contains the following instruments/equipment:

- optical microscope
- The KLA Tencor D-120 unit is a surface topography machine. It is purely mechanical in nature and no chemical products are used during its operation.
- The Trion instrument is a Reactive Ion Etcher which involves plasma etching of silicon and silicon-based thin films. It uses sulfur hexafluoride and oxygen gases. It is not yet connected pending installation of the necessary 208V electrical outlets to be installed by the local Public Works Department.
- The Deposition Controller instrument deposits gases on IC chips.
- The Angstrom Engineering Covap instrument is a resistive metal evaporator. It is used to deposit thin films of various metals on various surfaces. To date, the metal films deposited include iron, aluminum, and nickel, and eventually there are plans for use of gold and chromium.

*** = reproductive hazard**

WORK TASK	POTENTIAL HAZARD	WORKERS INVOLVD	FREQUENCY/DURATION	MONITORING RECOMMENDED?
Angstrom Covap unit	Fe, Al, Ni	6	Varies	No-see EA Chem

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey	Dept: Physics	Work Center: NanoMEMS Rooms
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IH EXPOSURE ASSESSMENT (EA)

NOISE: The equipment used does not generate noise.

CHEMICALS: Deposition of very small amounts of iron, aluminum, and nickel on parts in a well-ventilated laboratory hood will not result in exposures exceeding the MSALs and OELs. Chemical exposure assessments for other processes using solvents, acids, and other chemicals cannot be made at this time since the involved chemical products are not used during any of the processes currently conducted or planned for the near future. These assessments will be made when the chemicals are procured and the planned processes occur.

RADIATION: Operations involving potential exposures do not occur.

PERSONAL PROTECTIVE EQUIPMENT (PPE): Faceshields, chemical safety goggles, and neoprene rubber gloves and apron will be worn during changing out of sulfuric acid and sodium hydroxide solutions in the outdoor metal shed. The hazardous materials procurement and approval process will require establishment of PPE to be worn during the different processes so that they are performed in a safe manner and potential exposures to health hazards are eliminated or minimized. Clean room smocks, and nitrile or latex exam gloves are worn in the Prep and Clean Rooms.

ENGINEERING CONTROLS: Overhead Clean room ventilation system provides positive pressure to the Prep and Clean Rooms. Two high-tech laboratory flow hoods controlled by electronics located at their tops; the hoods are designed with an interlocking mechanism that will not allow processes to occur unless the hood sashes are completely closed. ***Note that the Departmental Lab Manager indicates that the Industrial Hygienist will be unable to periodically measure the flow rates of the hoods because the measuring equipment will not meet "Clean Room" cleanliness standards.***

RESPIRATORY PROTECTION PROGRAM: Operations performed do not require use of respirators, they are not currently used, and their elective use is not anticipated for future operations.

POTENTIAL HAZARD	NUMBER OF MEASUREMENTS	METHOD OF MEASUREMENT 1	METHOD OF MEASUREMENT 2	FREQUENCY (per year)	MAN-HOURS (per year)
None at this time					

Use the following codes: not applicable at this time.

Signature: Signed/ S. Eric Thurston, Industrial Hygienist	Date: 4 August 2011
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IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey	Dept: Physics	Work Center: Free Electron Laser (FEL) Lab
Location: New Bldg 230	Supervisor: Dr. Richard Swent	Phone: 831-656-2872
Workers: 5 staff + 1 female student, but the # and sex of future students could vary by quarter, 1 male contractor	Male: Currently 4 staff	Female: Currently 2 (1 staff and 1 student)

Operations: The lab has just become operational and work now mainly consists of putting the components of an important part of the system together, and the lab is expected to ramp up its operation over the next two years. There are two parts to this building: the lab itself and the vault. The vault is where the FEL will be located and fired, but this laser is not currently operational. The wall allowing access to the vault and serving as a barrier between the vault and lab has not been erected yet. The walls of the building and the barrier wall are/will be made of concrete only, with no lead shielding inside.

The following chemical products are currently in use at this location:

- Performix Plasti Dip Multi-Purpose Rubber Coating is applied to tools by dipping into the coating.
- Anhydrous 99% isopropyl alcohol. Several gallons were applied using sponges to clean the soft walls of the clean room during its setup, and that was a one-time job. It is currently primarily used for cleaning parts prior to entry into a vacuum system, with absolute 99.5% ethyl alcohol used for the same cleaning and degreasing process. Acetone would be used for the same purpose where the isopropyl alcohol is insufficient in chemical cleaning residue and material from parts. Both products are applied using cotton swabs or disposable Kimwipes.
- One aerosol can of WD-40 lubricant is staged in the building, but has not been used yet.
- Besides its use described above, absolute 99.5% ethyl alcohol is also used for cleaning of laser optics, and it too is applied using cotton swabs or disposable Kimwipes.
- Liquid nitrogen is used for cooling the heat shield in the accelerator cryomodule and to pre-cool the helium space in the cryomodule.
- Liquid helium is used to cool the superconducting accelerator cavities.
- Gaseous carbon dioxide is staged but has not be used yet. Its anticipated use is for cleaning particulates from vacuum parts using a "CO2 snow" system.

*** = reproductive hazard**

IH EXPOSURE ASSESSMENT/MONITORING PLAN

WORKPLACE INFORMATION

Organization: Naval Postgraduate School, Monterey **Dept:** Physics **Work Center:** Free Electron Laser (FEL) Lab

Operations (continued): -Gaseous helium is used to pressurize the liquid helium and force the liquid into the cryomodule.

-*Lead-tin solder is used to perform small scale soldering of a variety of different wires and connectors. This process mainly involves use of soldering irons, with soldering guns used for work involving very large conductors.

-A Makita electric hand drill and Hilti (electric) hammer drill were used while setting up the lab, mainly to anchor the vault cage to the floor. Neither tool is expected to be used again during the upcoming year.

-There are two small portable Hitachi air compressors present that are used to enable operation of pneumatic actuators that position diagnostics; their use is anticipated for the next couple of years until a central compressor with distribution pipe outlets in the entire building is installed outside. The pneumatic actuators use very little air volume, and thus the compressors generally only operate for a few minutes every one or two hours.

-Dayton and PC Eagle wet-dry vacuums are used irregularly and rarely for general removal and cleanup of debris from work areas, and would only be used for a few minutes per day.

-An electric Dremel rotary tool is used rarely, irregularly and briefly for marking lab property identity and for small scale grinding and cutting processes.

-3 red electric heat guns are used for heating plastic heat shrink tubing for placement over electrical wiring and also for melting ice blocks on the lab's cryogenic system.

*** = reproductive hazard IM = intermittent operation**

WORK TASK	POTENTIAL HAZARD	WORKERS INVOLVD	FREQUENCY/DURATION	MONITORING RECOMMENDED?
Rubber coating	*Tol,*xyl,slvnts	5	3x/yr, 2 ozs	No-see EA Chem
*Isoprop alcohol	*Isop alcohol	5	1 liter/yr	No-see EA Chem
Acetone	Acetone	5	<1 liter/yr	No-see EA Chem
*Ethyl alcohol	*Ethyl alcohol	5	1-2 liters/yr	No-see EA Chem
Liquid N2	Nitrogen	5	17K ltrs/yr	No-see EA Chem
Liquid He	Helium	5	3K ltrs/yr	No-see EA Chem
Gas CO2	Carbon dioxide	5	50-100 lbs/yr	No-see EA Chem
Gas He	Helium	5	8 K cyldrs/yr	No-see EA Chem
Soldering	*Lead, tin fumes	5	1 hr/dayMaxIM	No-see EA Chem
Air compressors	*Noise	5	Few mins/hr	No-see EANOise

IH EXPOSURE ASSESSMENT/MONITORING PLAN (continued)

WORKPLACE INFORMATION

Organization: Naval Postgraduate School	Dept: Physics	Work Center: FEL Lab
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IH EXPOSURE ASSESSMENT (EA)

NOISE: The measured noise level of the Hilti hammer drill exceeds the Navy criterion level, but it was only used in the past during lab setup and there is no anticipated use in the coming year.

-The measured noise levels of the Makita hand drill, both wet-dry vacuums, and heat guns are below the Navy criterion level.

-The noise levels of the portable air compressors exceed the Navy criterion level, but the 8-hour TWA exposure assessment is below the NOEL.

CHEMICALS: Minimal usage of the rubber coating, *isopropyl and *ethyl alcohols, and acetone will not result in exposures exceeding the MSALs and OELs.

-Liquid nitrogen and helium mainly present an extreme cold skin contact hazard, but this contact is prevented by use of thermal gloves to handle flasks and other containers of these liquid gases.

-The large volume of air present in the building will dilute any gaseous nitrogen and helium introduced into the work environment from increasing to concentrations that create asphyxiating (IDLH) atmospheres.

-Monitoring data collected during soldering operations conducted in a variety of Navy settings indicates exposures are below the MSAL and OEL for tin fumes, and below both the AL and PEL for *lead.

RADIATION: Operations involving potential exposures do not occur since the laser is not currently operational.

PERSONAL PROTECTIVE EQUIPMENT (PPE): Faceshield and Tempshield Cryo-Gloves thermal gloves during handling or filling of liquid helium and liquid nitrogen flasks.

-Disposable ear plugs or ear muffs during use of the hammer drill and when turning the air compressors on or off.

ENGINEERING CONTROLS: None.

RESPIRATORY PROTECTION PROGRAM: Operations performed do not require use of respirators, and they are not worn on an elective basis.

* = reproductive hazard

POTENTIAL HAZARD	NUMBER OF MEASUREMENTS	METHOD OF MEASUREMENT 1	METHOD OF MEASUREMENT 2	FREQUENCY (per year)	MAN-HOURS (per year)
None					

Use the following codes: not applicable at this time.

Signature: Signed/ S. Eric Thurston, Industrial Hygienist	Date: 18 September 2011
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**APPENDIX B
HISTORICAL AIR SAMPLING RESULTS**

<u>DATE</u>	<u>JOB</u>	<u>STRESSOR</u>	<u>RESULTS, ppm</u>	<u>EXPOSURE STANDARDS, ppm</u>
Jul 04	Acrylic cement in the Machine Shop	Meth Cl	STE = 0.53 TWA= 0.017	STEL = 125 PEL = 25
Oct 01	Glass rods immersion in 100% solutions	TCE	None detected	STEL = 200, PEL = 50
		Toluene	None detected	STEL = 150, PEL = 100
		Benzene	None detected	STEL =5, PEL = 1
Oct 01	Cable immersion in 100% solution	Meth Cl	None detected	STEL = 125, PEL = 25
Oct 01	Star Brite Liquid Tape	Toluene	None detected	STEL = 150, PEL = 100
		Meth Cl	None detected	STEL= 125, PEL = 25

Note that, except for the acrylic cement, these products are no longer used during departmental operations.

Notes:

ppm = parts per million
Meth Cl = methylene chloride
TCE = trichloroethylene
STE = short time exposure
STEL = Short Time Exposure Limit
TWA = 8-hour Time-Weighted Average
PEL = Permissible Exposure Limit

**APPENDIX C
AIR SAMPLING RESULTS, RAIL GUN FIRING**

<u>DATE</u>	<u>JOB&PUMP LOCATION</u>	<u>STRESSOR</u>	<u>RESULTS, mg/m3</u>	<u>EXPOSURE STANDARDS, mg/m3</u>
9 Dec 10	#1	Aluminum	0.0155	5
		Chromium	0.00150	1
		Copper (fume)	0.0350	0.1
		Nickel	0.0033	1
		Iron Oxide Fume	0.0356	10
		Nickel	0.0123	1
		Silver	0.077	0.01
		Rest of metals	less than detectable levels	
		#2	All metals	less than detectable levels
	6 Oct 10	#3	Aluminum	0.0206
Chromium			0.00096	1
Cobalt			0.00084	0.05
Copper (fume)			0.0337	0.1
Nickel			0.0033	1
Silver			0.0132	0.01
rest of metals			less than detectable	
#4			Copper (fume)	0.0443
		Silver	0.0507	0.01
#5		Copper (fume)	0.00164	0.1
		Rest of metals	less than detectable	
#6		All metals	less than detectable	

- mg/m3 = milligrams per meter (of ambient air)
- Location #1 = inside wooden structure during Monolithic Rail Gun firing
- Location #2 = inside Room 037 on a side table approximately 5 feet from wooden structure during Monolithic Rail Gun firing
- Location #3 = inside wooden structure during Augmented Rail Gun firing
- Location #4 = inside wooden structure during Augmented Rail Gun firing
- Location #5 = outside wooden structure near opening in structure where electrical cables pass through during Augmented Rail Gun firing
- Location #6 = in room near rail gun firing operator during Augmented Rail Gun firing

**APPENDIX D
MEASURED EQUIPMENT NOISE LEVELS**

<u>LOCATION</u>	<u>SOURCE</u>	<u>READING</u>	<u>HAZARD RADIUS</u>
Bldg 232, Room 35	Delta Table Saw**	94 dBA	Entire Room
	Dewalt Miter Saw**	101 dBA	Entire Room
Rail Gun Machine	Craftsman Band Saw**	90 dBA	Entire Room
Shop/Wood Shop	No Name Horizontal Belt Sander**	85 dBA	2 feet
	Jet 6 Inch Jointer**	89 dBA	6 feet
	Compressed Air Nozzle	94 dBA	Entire Room
	Central Machinery 14 Inch Band Saw**	90 dBA	6 feet
	Biesenmayer Table Saw**	104 dBA	Entire Room
	Dewalt Yellow Cutoff Saw	96 dBA	12 feet
	Delta Rotary Drum Sander**	82 dBA	N/A
	Delta Drill Press	64 dBA	N/A
	Enco Drill Press**	65 dBA	N/A
	JET Jointer**	82 dBA	N/A
	Grizzly Combination Hori- zontal Belt/Vertical Disc Sander**	84 dBA	3 ft
	Shop Vac 20 Drum Vacuum	92 dBA	15 feet
	MB Dynamics Drum Vacuum	82 dBA	N/A
Bldg 232, Room 38	Baldor Vertical Belt Sander	92 dBA	Entire Room
Machine Shop	JL Wingert Vertical Disc Sander	85 dBA	1 foot
	No Name Horizontal Belt Sander	84 dBA	0 feet
	Miltronics CNC Mill Machine	70 dBA	N/A
	Harrison Swing Lathe	75 dBA	N/A
	Sharp 1760K Lathe	74 dBA	N/A
	Craftsman Wet Dry Vacuum	86 dBA	3 feet
	Supermax Manual Mill Machine	75 dBA	N/A
	Clausing Startrite Band Saw	89 dBA	8 feet
	Delta Dual Pedestal Grinder	85 dBA	1 foot
	Rutland Power Hacksaw	69 dBA	N/A
	Sears Dual Pedestal Grinder**	84 dBA	0 feet
	South Bend Drill Press	78 dBA	N/A
	High Speed Hammer Co. Drill	67 dBA	N/A
	DAREX Drill Sharpener	71 dBA	N/A
	Glendo Metal Sanding Wheel	69 dBA	N/A
	Craftsman Dual Pedestal Grinder	92 dBA	Entire Room

** no longer present in room

**APPENDIX D
MEASURED EQUIPMENT NOISE LEVELS (con'd)**

<u>LOCATION</u>	<u>SOURCE</u>	<u>READING</u>	<u>HAZARD RADIUS</u>
Bldg 232, Room 37 Rail Gun Lab	Rail gun	129 dB	N/A
Bldg 232, Room 37B Rail Gun Lab Machine Shop	Rail gun firing in Room 037 Grizzly low rpm Metal Band Saw	124 dB 78 dBA	N/A N/A
Bldg 232, Room 111	(Red) Master-Mite Heat Gun (Black) Ungar 1095 Heat Gun Black&Decker Electric Drill	<50 dBA 80 dBA 89 dBA	N/A N/A 6 feet
(New)Bldg 230 FEL Lab	Hitachi Air Compressor Dayton Wet-Dry Vacuum Hilti Hammer Drill Makita Electric Hand Drill Master Heat Gun PC Eagle Wet/Dry Vacuum	85 dBA 76 dBA 87 dBA 80 dBA 78 dBA 83 dBA	3 feet N/A 4 feet N/A N/A N/A

**APPENDIX E
FIELD NOISE SURVEY FORMS**

INDUSTRIAL HYGIENE NOISE SURVEY FORM

Date: 17 Aug 11 IH UIC: 39162 Activity: Naval Postgraduate School,
 UIC: 62271 Monterey, Physics Dept

Shop Location: (New) Bldg 230 Shop Code/Name: FEL Lab

Area Posted: Yes (Single or Double) No

Hearing Protection In Use: Yes No

Sound Level Meter Results

Item #	#1	#2	#3	#4	#5
Source Description	Hitachi Model EC-79 Air Compressor	Dayton Model 3VE21A Wet/Dry Vacuum	Hilti Model TE 6-5 Electric Hammer Drill	Makita Model 6408 Electric Hand Drill	Master Model HG-501A Electric Heat Gun
Machine#/USN#	No S/N	S/N 7023	S/N 202298	S/N 243693A	No S/N
Noise Pattern: C = Continuous IN = Intermittent IM = Impulse/Impact	XC IN IM	XC IN IM	XC IN IM	XC IN IM	XC IN IM
Noise Source Labeled	X Yes No	Yes X No	X Yes No	Yes X No	Yes X No
Noise Radius (ft)	3	N/A	4	N/A	N/A
Meter Response F = Fast S = Slow I = Impulse/Impact	F XS I	F XS I	F XS I	F XS I	F XS I
Results	85 dBA	76 dBA	87 dBA	80 dBA	78 dBA

Comments: Only items # 1 and 3 generate noise levels that exceed the Navy criterion level of 84 dBA, and hearing protection during their use needs to continue.

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Area Posted: Yes (Single or Double) No

Hearing Protection In Use: Yes No

Sound Level Meter Results

Item #	#6				
Source Description	PC Eagle Model 415P Wet/Dry Vacuum				
Machine#/USN#	S/N 036046				
Noise Pattern: C = Continuous IN = Intermittent IM = Impulse/Impact	XC IN IM				
Noise Source Labeled	Yes XNo				
Noise Radius (ft)	N/A				
Meter Response F = Fast S = Slow I = Impulse/Impact	F XS I				
Results	83 dBA				

Comments: None. The noise level of item #6 does not exceed the Navy criterion level of 84 dBA.

SOUND LEVEL METER		MICROPHONE		CALIBRATOR	
Mfg: SIMPSON		Mfg: SIMPSON		Mfg: SIMPSON	
Model: 886-2	Serial #: 007066	Model:	Serial #: 30394	Model: 890-2	Serial #: 73314
Last Electro- acoustic Cal Date: 11 Jul 11	Next Electro- acoustic Cal Date: 11 Jul 12	Last Electro- acoustic Cal Date: 11 Jul 11	Next Electro- acoustic Cal Date: 11 Jul 12	Last Electro- acoustic Cal Date: 11 Aug 11	Next Electro- acoustic Cal Date: 11 Aug 12
Field Calibration: Pre Cal Date: <u>17 August 2011</u> Post Cal Date: <u>17 August 2011</u>					
Field Calibration OK: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No					
Field Calibrated By: <u>Eric Thurston</u>					
Measurements Obtained: <input checked="" type="checkbox"/> Indoors <input type="checkbox"/> Outdoors					
Wind Screen: <input type="checkbox"/> Used <input checked="" type="checkbox"/> Not Used					
Sampler: <u>Eric Thurston</u> Date Completed: <u>17 August 2011</u>					
Reviewing IH: <u>Michael J. Puckett</u> Date Reviewed: <u>23 August 2011</u>					
Data Entered By: <u>Eric Thurston</u> Date Entered: <u>17 August 2011</u>					

APPENDIX F
SKETCH OF MEASURED NOISE LEVELS
DURING AUGMENTED RAIL GUN FIRING

The following pages depict the measured noise levels and measurement locations during firing of the Augmented Rail Gun on 6 October 2010.

INDUSTRIAL HYGIENE DIAGRAM

Date: 6 OCTOBER 2010

Continued from:

Survey #: _____

Survey Type: Walk Through
 Air Sample
 Noise/Noise Dosimetry

Heat Stress
 Bulk/Wipe
 Direct Reading

Geographic Unit:
 NPS Member _____
 Site

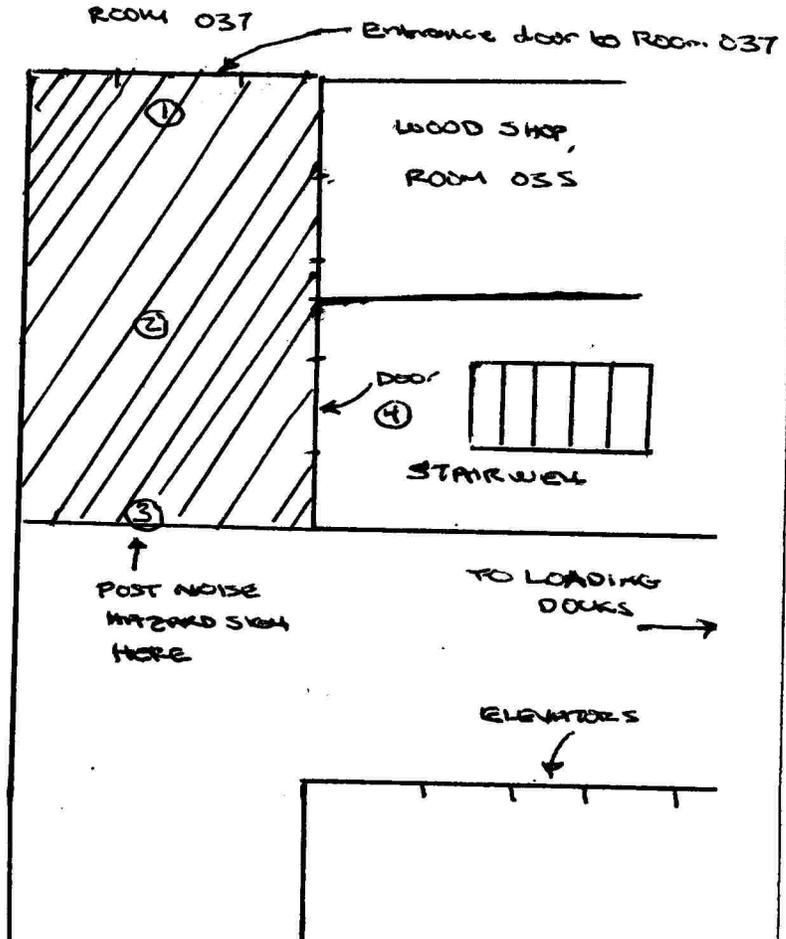
Spongel
 Hall
 Location

Rezonat
 Sub-Location

Near Rooms 035
 § 037
 Area

= Noise Hazard Zone

CRITERION FOR
 IMPACT NOISE
 (dB Flat) = 140 dB,
 CRITERION FOR
 CONTINUOUS NOISE
 (dBA) = 84 dBA



LOCATION #	READING
①	98.0 dB (Flat)
①	89.0 dBA
②	94.0 dB (Flat)
②	86.0 dBA
③	84.0 dBA
④	64.6 dBA

dB (Flat) = impact noise reading
 dBA = continuous noise reading, A-weighted scale

ENCLOSURE (2)



INDUSTRIAL HYGIENE DIAGRAM

Date: 6 OCTOBER 2010

Continued from:

Survey #: _____

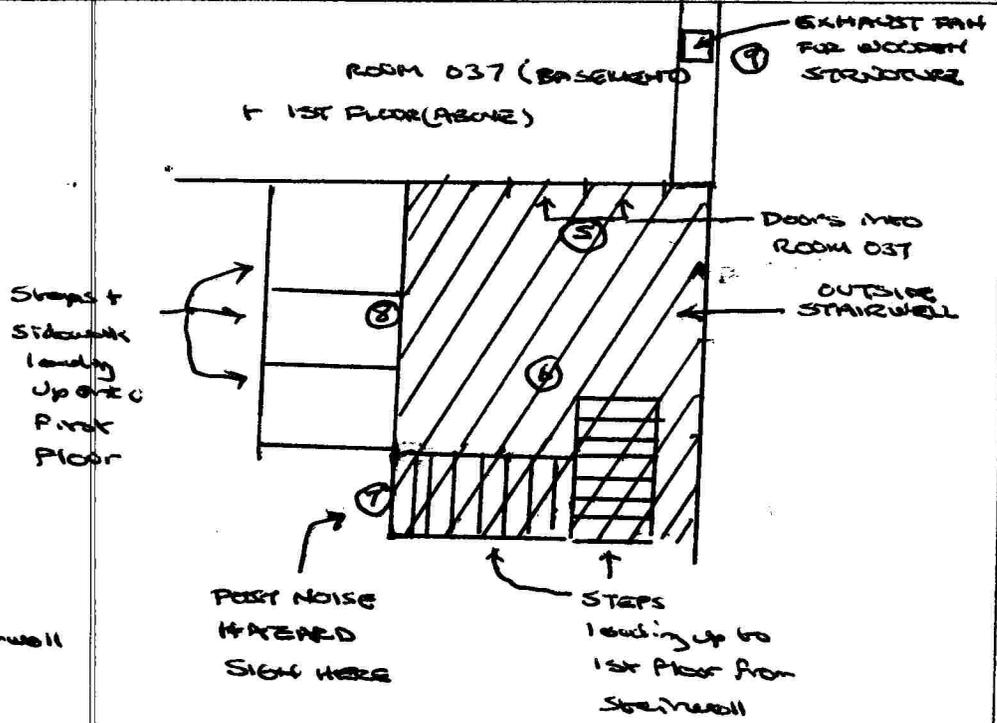
Survey Type: Walk Through
 Air Sample
 Noise/Noise Dosimetry

Heat Stress
 Bulk/Wipe
 Direct Reading

Geographic Unit:
 NPS Working
 Site

Stairwell
 Hall
 Location

Staircase + immediate area outside
southwest corner of building
 Sub-Location Area



/// = Noise Hazard Zone
 Entire stairwell (including stairs)

LOCATION #	READING
5	90.1 dBA
6	89.3 dBA
7	81.6 dBA
8	82.8 dBA
9	64.6 dBA

dBA = continuous noise reading, A-weighted scale



APPENDIX G
LOCAL EXHAUST VENTILATION
SYSTEM EVALUATION

The laboratory fume hood in Spanagel Hall, Room 000 has not been used by departmental personnel in the past several years since the entire room has been under the sole control of the NPS Radiation Safety Officer (RASO). **The air flow rate of the hood will need to be measured when the room is turned back over to the Physics Department.**

Two high-tech laboratory flow hoods controlled by electronics located at their tops are present in the Watkins Hall, Room 214 10,000 level Clean Room; the hoods are designed with an interlocking mechanism that will not allow processes to occur unless the hood sashes are completely closed. The Departmental Lab Manager indicates that the Industrial Hygienist will be unable to periodically measure the exhaust flow rates of the hoods because the measuring equipment will not meet "Clean Room" cleanliness standards, and subjecting the equipment to cleaning to meet these standards will necessitate factory recalibration, which is not performed in an environment meeting these cleanliness standards.

APPENDIX H
RESPIRATORY PROTECTION PROGRAM MATRIX

Respirators are not required and are not worn on an elective basis during departmental operations.

**APPENDIX I
MEDICAL SURVEILLANCE PROGRAM MATRIX**

COMMAND: Naval Postgraduate School, Monterey DATE: August 2011
DEPARTMENT: Physics

DESIGNATED PERSONNEL	MEDICAL SURVEILLANCE PROGRAM
Room 5 Laser Development Teaching Lab class IIIb or IV laser operations	Laser Radiation (506)
Room 6 Raman Lab class IIIb laser operation	Laser Radiation (506)
Room 27 class IV Gas Gun Research Lab laser operation	Laser Radiation (506)
Machinist/Model Maker	Noise (503), Metal Working Fluids (162)

1. Occupational health examinations can be scheduled by contacting Ms. Flora Dela Pena, Occupational Health Nurse at the Presidio of Monterey, Army Medical Clinic. Her contact information is 831-242-4532, flora.delapena@us.army.mil. Their policy is to have the supervisor(s) contact them for scheduling instead of individuals scheduling themselves.

2. Only a Laser Radiation baseline and termination medical exam **would be necessary for those personnel who would, although unplanned and not foreseen for the near future, operate the class IIIb free space lasers currently in storage.** After the initial exam, a follow-up exam would only be necessary if there was an accidental eye exposure incident during laser use. Enrollment in the Laser Safety medical surveillance program can also be determined by the NPS Laser Systems Safety Officer (LSSO), Mr. Kerry Yarber, or the current NPS Assistant LSSO, Mr. James Calusdian.

3. The Noise and Metalworking Fluids exams are required yearly.

4. **The supervisor can also make judgement on enrollment of personnel in the Forklift Operator (Code 710) medical surveillance program based on job titles, positions, or duties since it does not require a hazard-based exposure assessment by the Industrial Hygienist.**

APPENDIX J
OCCUPATIONAL HEALTH-RELATED TRAINING MATRIX

COMMAND: Naval Postgraduate School, Monterey DATE: August 2011
 DEPARTMENT: Physics

PROCESS	ESAMS TRAINING MODULE
Machinist/Model Maker	Hearing Conservation (110), PPE (Initial Only) 1398, Occupational Reproductive Awareness (1242)
Rail Gun Lab personnel	PPE (Initial Only) 1398
NanoMEMS operations, including Rooms 213/214 Clean Rooms	PPE (Initial Only) 1398
Lead-tin soldering	Lead Awareness (322), Occupational Reproductive Awareness (1242)
Handling of lead bricks in the Spanagel Hall basement Storage Room	Lead Awareness (322), Occupational Reproductive Awareness (1242)
Use of Scotchkote Electrical Coating, aerosol paint cans, alcohols, or Flux-Off Soldering Flux Remover	Occupational Reproductive Awareness (1242)
Use of Shipcoat Primer in the Room 27 Gas Gun Research Lab	Occupational Reproductive Awareness (1242)
Use of Novahol Cleaner/Detergent during Watkins Hall Clean Room operations	Occupational Reproductive Awareness (1242)
Chemical cleaning with alcohols, FEL Lab	Occupational Reproductive Awareness (1242)
Use of latex, nitrile rubber, or similar exam gloves for handling chemical products	PPE (Initial Only) 1398
Use of laser goggles	PPE (Initial Only) 1398
Hazardous Materials Users	HAZCOM Initial Training (1169)*
Supervisors of Hazardous Materials Users	HAZCOM Training For Supervisors (1058)*

All training is required annually except as noted.

* Per Chapter 6, Appendix 6-B of OPNAVINST 5100.23 personnel also need to receive documented initial training covering their work center's MSDSs, with MSDS training repeated whenever new chemical products are introduced into the workplace.

**APPENDIX K
GLOSSARY**

TERM	MEANING
AL	Action Level - Normally half of PEL. Exposure level at which air sampling, employee training, and medical surveillance are required.
ACGIH	American Conference of Government Industrial Hygienist
AC/HR	Air Changes Per Hour
ANSI	American National Standards Institute
AQS	Air Quality Standard
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASTC	Aviation Survival Training Center
C	Ceiling - Toxic material exposure level which cannot be exceeded for any length of time.
CFM	Cubic Feet Per Minute
CFR	Code of Federal Regulation
EL	Excursion Limit - Concentration limit which cannot be exceeded at any time.
EAMP	Exposure Assessment/Monitoring Program. A program to evaluate workplace health hazards through surveys and exposure measurement.
EPA	Environmental Protection Agency
ERT	Emergency Reclamation Team
FC	Footcandles
F/CC	Fibers Per Cubic Centimeter. A means for expressing airborne asbestos fiber concentrations.
FeA	Field Area
FiA	Filter Area
FPM	Feet Per Minute
FT3	Cubic Feet
HDI	Hexamethylene Diisocyanate
HEPA	High Efficiency Particulate Air
HM	Hazardous Material
HMC&M	Hazardous Material Control and Management
HW	Hazardous Waste
IES	Illumination Engineering Society
IH	Industrial Hygiene
L	Liter
LPM	Liters Per Minute
LOD	Limit of Detection
LOQ	Limit of Quantitation
MG/M3	Milligram Per Cubic Meter of air. A means of expressing concentrations of dust and metal fumes in the air.

APPENDIX K
GLOSSARY (continued)

TERM	MEANING
MSAL	Medical Surveillance Action Level. Concentration of air contaminant at which medical surveillance examinations must be provided to exposed personnel.
MSDS	Material Safety Data Sheet. A form used by manufacturers to communicate to users the chemical and physical properties of their products.
MSM	Medical Surveillance Matrix
NAVOSH	Navy Occupational Safety and Health
NEHC	Navy Environmental Health Center
NIOSH	National Institute of Occupational Safety and Health
OEL	Occupational Exposure Limit
OH/PM	Occupational Health/Preventive Medicine
OSHA	Occupational Safety and Health Administration
OV	Organic Vapor
PPE	Personal Protective Equipment
PPM	Parts Per Million. A means of expressing the concentration of gases and vapors in the air.
PSI	Pounds Per Square Inch
RF	Radio Frequency
SOP	Standard Operating Procedure
SQFT	Square Feet
STEL	Short Term Exposure Limit. A 15 minute time weighted average exposure which should not be exceeded at anytime during a workday.
STRESSOR	Potential hazard (e.g. Noise, Chemicals, Dusts, etc.)
TLV	Threshold Limit Value. Established by ACGIH as levels of airborne contaminants or physical hazards under which it is believed workers may be exposed on a daily basis without adverse effect.
TWA	Time Weighted Average. A method of averaging varying concentrations over a specified period of time, usually 8 hours.
UG	Microgram
VOL	Volume
>	Greater Than
<	Less Than

**APPENDIX L
CHANGE OF OPERATION NOTIFICATION**

Please use this form to notify the Industrial Hygienist of any changes to operations. This form needs to be completed and e-mailed to S. Eric Thurston, Industrial Hygienist, at sethurst@nps.edu.

POINT OF CONTACT:

TELEPHONE:

E-MAIL ADDRESS:

BLDG/ROOM #:

COMMAND/DEPARTMENT/SHOP: NPS, Physics

INSTRUCTIONS:

The routine industrial hygiene survey process evaluates potential hazards to employees based on existing operations at the time of the survey. When operations change, the potential hazards can also change, and these new conditions need to be evaluated. Please notify the Industrial Hygienist if any of the following occur:

- a. New operations with suspected health hazards are performed
- b. New chemical products are used (please attach a brief list and only the page(s) of associated MSDS's listing the product's manufacturer, product name, and the chemical ingredients)
- c. An increase in major chemical usage
- d. New equipment with potential noise hazards is used
- e. Other new equipment posing suspected or known health hazards, such as lasers, is used
- e. Exposure frequency and time changes of operations with potential or known health hazards
- f. A change in local exhaust ventilation systems

List any changes below.

Date forwarded: _____