Environment, Health, and Safety Office - FY2017

Executive Summary

The Environment, Health and Safety Office (EHS) is an institutional compliance office as well as a service and operations department. It supports the Institute's environment, health, and safety mission associated with education, research, and operation of our endeavors in Cambridge, at Lincoln Laboratory, and worldwide.

In order to reduce the risks inherent with new and innovative research, EHS needs to guide the Institute in early risk assessments in order to embed mitigation practices and designs into the research proposals and to ensure appropriate safeguards are present in spaces where work is conducted. Our programs helped us to recognize predictive indicators that could put the Institute at risk if not done carefully with safety in the planning stages.

Over the last few years, we have seen significant increases in battery research which typically uses highly reactive and energetic materials, and in conversion of traditional machine shops to digital fabrication studios (*Makerspaces*), which present new types of hazards to shop users, the use of unmanned aerial vehicles (drones), growth in Nanotechnology and synthetic biology. We anticipate future advancements in autonomous underwater and on-road, off-road vehicles that will require assessment of the hazards and risks imposed.

We have a history of planning for safety by following the scientific literature, tracking where the funding is coming from, the research trends, interaction with our peers, and from interactions with our leading Faculty. In more recent trends we have seen Engineering moving into the biological sciences and the increase of unmanned vehicles; as well as undergraduate students conducting more hands on activities with hazardous materials and equipment (Makerspace and UROP). This requires EHS to re-evaluate the design requirements for engineering facilities and for the training needs of engineers and students. The potential for the ENGINE to operate on campus will present additional challenges for EHS.

Enabling MIT's Mission

Development of Safety Culture for Laboratories

Laboratories at MIT have unique cultures with one common theme: they are places of academic and research excellence. A subset of this theme of excellence is superior safety performance, although many times this aspect is not explicit. Bringing out the importance of a strong culture supporting safety is important and has been mentioned in at least two departmental visiting committee reports. EHS has launched programs to increase safety performance and cultural awareness including campaigns, awards, awareness-building events, and a commitment by Department, Laboratory, and Center leaders to a high awareness of safety and caring.

Faculty/Principal Investigator (PI) Responsibilities

In FY 2011, we began an initiative to conduct new Faculty/Principal Investigators (PIs) EHS orientation. We expanded it to include an overall presentation and discussion for all Faculty. This is an effort to help Faculty understand their EHS responsibilities and become aware of the resources available to assist them. It is done at either departmental Faculty meetings or one-on-one meetings. Although not a regulatory requirement, this has been completed by 182 out of 459 (40 %) PI's with hazards in our EHS Space Registration database. In FY 2018, we plan to continue this outreach as part of our safety culture initiative.

Emergency Preparedness Planning

In FY 2015, we made significant strides verifying that approximately 95% of the DLC's have a completed Emergency Preparedness Plan. We used a new model for all-hazards emergency preparedness plans (EPP) to be used by DLCs across the Institute in collaboration with the Office of Emergency Management & Business Continuity. We used an all-hazards emergency preparedness plan template, available at https://ehs.mit.edu/site/about-ehs/emergency-management, which consolidates evacuation procedures, communications protocols, shelter-in-place measures and OSHA Fire Prevention requirements into a five-worksheet Excel document. In FY 2017, we collaborated with the Office of Emergency Management & Business Continuity to develop appropriate training and system to update EPPs.

Makerspace

In keeping with MIT's motto "mens et manus" (mind and hand), several campus initiatives have recently been completed that have advocated for more hands on learning at MIT (Future of Education) and better access to shops by students during off hours and outside of the course curriculum (Innovation Initiative). These studies, coupled with the exciting new developments in digital fabrication, have led several student groups to gain momentum in their requests for student run shops. One has been completed in Building 35 for Mechanical Engineering. New House has done considerable work in putting together a governance charter and funding for a space serving three dorms. There are several EHS related challenges that need to be addressed including: supervision, training, access restrictions, working alone, hours of operation, design and layout of shop spaces and safety features needed.

We are working closely with Professor Culpepper, the Makerspace leader and his team to develop facility design standards and training programs. Makerspaces are expanding beyond typical machine shops to involve biological materials (Bio Makerspaces) and we are preparing for expansion into other areas such as radiation.

Comprehensive Laboratory Hazard Assessment

The Association of Public Land Grant Universities (APLU) report issued this year identified that a casual factor of tragic incidents that have occurred in universities these past four years has been the lack of a comprehensive hazard assessment before starting a procedure. There are currently several programs that assess a specific hazard in a laboratory and/or register /document

conditions in the laboratory. However, there is not a comprehensive assessment of each laboratory based on the complete information available and review of specific activities performed in the laboratory is limited typically to those required (i.e. Biosafety protocol reviews and Radiation authorizations). The Lab Hazard Assessment (LHA) pilot started in FY 2013 was well received and expanded subsequent years. We have conducted LHAs in more than 70 PI groups in 12 Departments, Labs and Centers (DLCs) to date.

International Agreements

Our major effort this year was to support the Singapore-MIT Alliance for Research and Technology (SMART) agreement. Support for SMART has focused on implementing the Institute's EHS Management System for adoption by SMART and provide technical support for some of the more hazardous operations. We participated in an audit of the EHS system conducted by the Singapore agency managing the facility.

In addition, we have provided assistance to other MIT collaborators including Masdar Institute Cooperative Program (MICP), King Fahd University of Petroleum and Minerals (KFUPM), and Singapore University of Technology and Design (SUTD). Furthermore, we have provided advice to our international colleagues in Japan, Brazil, South Korea, China, and Turkey who look to MIT as a leader in EHS programs.

Laying the Foundation for the Future

Significant Laboratory Design Reviews

EHS has been an active in the review of designs for lab renovations, capital improvements to spaces and for larger projects such as MIT.nano and the Building 31 complete renovation. Involvement in lab design enables EHS to assist in bringing some of the physical features into new and renovated spaces to allow for specific safety culture elements to take hold. Laboratory ventilation, hazardous gas monitoring, chemical storage, hazardous waste handling, and waste water treatment are just some of the areas we frequently address. Minimizing community impact during the many construction projects is another area of focus.

In FY 2015, the EHS Office began a transition to a new organizational structure that will allow for more efficient support of the design review and construction safety process. The addition of two new FTE's and the repurposing of portions of several existing FTE's to support this function has been completed. In FY 2017, Campus Construction and EHS finalized and began implementation of the process that is being used to assure adequate EHS support. In the fiscal year EHS participated in 354 total projects representing over $1 billion in construction work. Projects ranged from large capital projects to Capital Renewal, Space Change, Utilities, Energy, Special projects and Facilities – Comprehensive Stewardship Group managed and other projects. The majority of the lead contact work (Project Liaison or Construction Safety Liaison) was performed by 6 EHS staff members with 24 staff participating on at least one project. In addition to serving as the direct contact numerous technical EHS staff provided support to projects.

Updating the Master Plan for Campus Waste Water

Our work with Campus Engineering and Construction and Maintenance and Utilities on the FY 2012's Notice of Violation for mercury and FY 2013's Notice of Non-compliance for copper from MWRA, and future needs for MIT.nano has brought all to agree that a study to update the Campus waste water master plan and probable expansion of the system is necessary. This was initiated in FY 2015 and is an on-going project.

Integration of Bio and Rad Protocol and Authorization Processes

Many research governance approvals share an approval route through various Institute committees for biological and radiation work or working with animals in research or with humans as experimental subjects. Collaboration efforts such as common questionnaires or pre-thought formats could enable a laboratory to prepare one set of approval protocols that could satisfy multiple levels of governance.

EHS completed a discovery effort this year to determine the feasibility and barriers to automate and integrate the process to approve and authorize biological research protocols and the use of radiation in our laboratories. Hundreds of these approvals are presently managed each year using a largely manual process that costs laboratory personnel significant time to prepare. We have selected a vendor (On-site Systems) and several modules of the software (EHS Assist) and will conduct a three month pilot operation in FY 2018 to determine the benefits.

Transforming Experiences through Collaboration

eShipGlobal Software Project Pilot

After careful evaluation, we believe this software can simplify the shipping process for the MIT community, reduce overall costs, and enhance compliance for shipping of hazardous materials and export controls. This is a collaboration between Procurement, Office of Sponsored Programs (OSP), several DLC's, and EHS. By the end of FY 2017, eight DLC's and 786 users have implemented the system. Goals include increased compliance with US Departments of State and Commerce export and US Department of Transportation hazardous materials regulations and this reduced risk to the Institute, and added benefits are a simplified shipping process and reduced shipping costs for the Institute.

Chemical Inventory

Since its launch in 2015, 181 lab groups have uploaded their chemical inventories into the CISPro Cloud platform provided by the EHS Office. This represents close to half of all the labs on campus using chemicals. There are also over 100,000 chemical containers in these lab inventories, spread over 23 Departments, Labs and Centers.

To support the needs of this important EHS initiative, the Technology Support Team provides a dedicated staff member to assist new and existing customers. The Chemical Inventory Technologist meets with labs, demonstrates the CISPro Cloud Chemical Inventory software,

trains lab members in the its use, provides data upload templates and hands on data cleansing services. This hand-on user support is a key factor in growing the use of the central chemical inventory solution at MIT.

During FY 2017 the following was accomplished by the Chemical Inventory staff and program:

- 34 new PI Lab Groups have uploaded lab inventory CISPro Cloud;
- 114 user logins have been added to the system;
- 70 labs are now using a generic "all lab member" login and password;
- 15,953 new chemical containers have been uploaded, with an additional 3,861 being added directly to the system;
- Provided more than 90 trainings and software demos or introductions to single or groups of lab members to teach them how to use the platform to maintain their inventory or to interest them in using the platform for future inventory management;
- 4 labs took advantage of the opportunity re upload their data to reflect their current inventory; and
- 1,186 containers disposed by labs in the system and 4 labs removed and replaced 2,262 containers during an upload to completely refresh their inventories due to major clean outs.

Outreach

We have continued our efforts to reach out to key groups at the Institute in order to communicate emerging EHS issues and obtain feedback regarding barriers they face and how best we can help them maintain safe and healthy conditions and compliance with regulations. The approach is to identify people at the Institute with similar functions and EHS challenges and bring them together periodically to discuss the issues. There are currently five groups meeting at least quarterly: machine shop supervisors; laboratory managers; DLC EHS Coordinators; Department of Facilities Repair & Maintenance (R&M); custodial and utilities managers; and DLCs building/Facility Managers. These have been very effective in establishing two-way communications and solving difficult problems.

Compliance Related Activities

Table 1. Shows the routine regulatory reports and inspections that are were performed in FY 2017. EHS is the main liaison with these agencies and accompanies them on inspections and submits the required reports. In addition, we have periodic unannounced inspections each year.

Table 1. MIT EHS Regulatory Compliance Calendar

July	August	September
• Monthly DMR for NPDES Permit • Quarterly Submit NPDES DMRs for NPDES cooling waste discharge to Charles River • DOT Hazmat registration • MassDEP Title V Compliance Certifications • MassDEP / EPA NOx Excess Emissions Report • Testing of samples from the MIT pools for bacterial contaminants	• MRCP License renewal • Analytical X-Ray Registration renewal • LLRW Renewal • Accelerator Registrations renewal • Monthly DMR for NPDES Permit • CAB/ESCRO meeting	• Radiation Protection Committee Meeting • Functionality testing of accelerator interlock/security systems • Functionality testing of RPP irradiator security systems with MIT Police, Facilities Operations Center, and IS&T. • MRCP Broad Scope License Renewal (every five years; due 9/2017) • Monthly DMR for NPDES Permit • City of Cambridge inspectional Services – Annual Certificates of Occupancy Inspection • CPHD Ice Skating Ink Certificate • CAB/ESCRO Meeting
October	**November**	**December**
• Monthly DMR for NPDES Permit • Quarterly Submit NPDES DMRs for NPDES cooling waste discharge to Charles River • MassDEP / EPA NOx Excess Emissions Report • CAB/ESCRO Meeting • Testing of samples from the MIT pools for bacterial contaminants	• Explosive User Certificate • NMMSS Reconciliation Report for SNM receipt/transfer • Monthly DMR for NPDES Permit	• Site Accelerator Registration Renewal • NRC Inspections • Reactor Safeguards Committee Meeting • Radiation Protection Committee Meeting • Functionality testing of accelerator interlock/security systems • Functionality testing of RPP irradiator security systems with MIT Police, Facilities Operations Center, and IS&T. • Analytical X-Ray Registration Renewal • Accelerator Registration Renewal • Monthly DMR for NPDES Permit • MassDEP Rideshare Submittal • CAB/ESCRO Meeting
January	**February**	**March**
• MassDEP Title V Compliance Certifications • Review of MIT Security Plan for irradiator facilities with MIT Police Chief • Review of MOA with Cambridge Police/Fire departments for irradiator emergency response plans • Monthly DMR for NPDES Permit • Quarterly Submit NPDES DMRs for NPDES cooling waste discharge to Charles River • MassDEP / EPA NOx Excess Emissions Report • Human embryonic stem cell research report to MDPH • CAB/ESCRO meeting • Testing of samples from the MIT pools for bacterial contaminants	• MRCP Inspection of "Increased Control" Security Program • Low Level Radioactive Waste Report • Monthly DMR for NPDES Permit • OSHA 300A Log • OSHA 300 Log • FM Global Insurance Inspection • Cambridge Biosafety Permit renewal • Report from the CAB/ESCRO to the City of Cambridge	• Annual Laser Inventory • NRC – CY Annual Report & Review of RRP Programs • Flammable Liquid Permits/Licenses Renewals • Annual Audit – Bates • SARA Report • EPA Greenhouse Gas Report • Radiation Protection Committee Meeting • Functionality testing of accelerator interlock/security systems • Functionality testing of RPP irradiator security systems with MIT Police, Facilities Operations Center, and IS&T. • Monthly DMR for NPDES Permit • Cambridge Stormwater Best Management Practice Operation & Maintenance Report • RCRA Report (March 2018) • CAB/ESCRO Meeting
April	**May**	**June**
• Annual Low Level Radioactive Waste Report • MassDEP Source Registration/Emission Statements • Annual RPP Program Audit • NRC Inspections • Monthly DMR for NPDES Permit • Quarterly Submit NPDES DMRs for NPDES cooling waste discharge to Charles River • MassDEP Greenhouse Gas Report • MassDEP / EPA NOx Excess Emissions Report • CAB/ESCRO meeting • Testing of samples from the MIT pools for bacterial contaminants	• Annual audit of MIT and WIBR radiation protection programs • Monthly DMR for NPDES Permit	• Radiation Protection Committee Meeting • Functionality testing of accelerator interlock/security systems • Functionality testing of RPP irradiator security systems with MIT Police, Facilities Operations Center, and IS&T. • Monthly DMR for NPDES Permit • MassDEP UST Compliance Certification • CAB/ESCRO meeting • Annual report to NIH Office of Science Policy from CAB/ESCRO
Intermittent		
• MRCP Inspection of Irradiator Security Program (every 2 years: expected 2019) • MRCP Inspection of Broad Scope license activities (every 3 years: expected 2020) • NRC Special Nuclear Materials Inspection (every 5 years: expected 2022) • NRC Special Nuclear Materials License Renewal: SNM-986 (every 10 years; renewed in 2017) • MDPH human embryonic stem cell research permit renewal (every 3 years; to be renewed Fall, 2017)		

NPDES: National Pollutant Discharge Elimination System
DMR: Division of Materials Research – National Science Foundation
DOT: US Department of Transportation
MassDEP: Massachusetts Department of Environmental Protection
NRC: Nuclear Regulatory Commission
EPA: US Environmental Protection Agency
RCRA: Resource Conservation and Recovery Act
SARA: Superfund Amendments and Reauthorization Act
OSHA: Occupational Safety and Health Administration
CPHD: Cambridge Public Health Department
MOA: Memorandum of Agreement
WIBR: Whitehead Institute for Biomedical Research
NMMS: Nuclear Materials Management and Safeguards Systems
SNM: Special Nuclear Material
MRCP: Massachusetts Radiation Control Program

Laboratory Wastewater Master Plan. Underlying issues identified with compliance with MWRA regulations led to a need for DoF and EHS to prepare a Scope of Work (SOW) and select a consultant to revise the 2000 Wastewater Master Plan for the Cambridge Campus. This plan will assess current conditions, define regulatory requirements, and prepare a draft study and treatment equipment standards and procedures.

Air Emissions. MIT Cambridge campus has an Air Quality Operating Permit (Title V permit) from MassDEP, required if the facility is a *major source* emitter of any criteria pollutant, NOx in this case.

Regulatory Interactions

NRC Routine annual inspection that resulted in no citations nor fines.

Cambridge Inspectional Services. Routine annual inspection of campus buildings. EHS and Facilities are working to correct the 281 findings identified in 250 buildings or spaces inspected. Approximately 95% were corrected in FY 2017.

Accomplishments

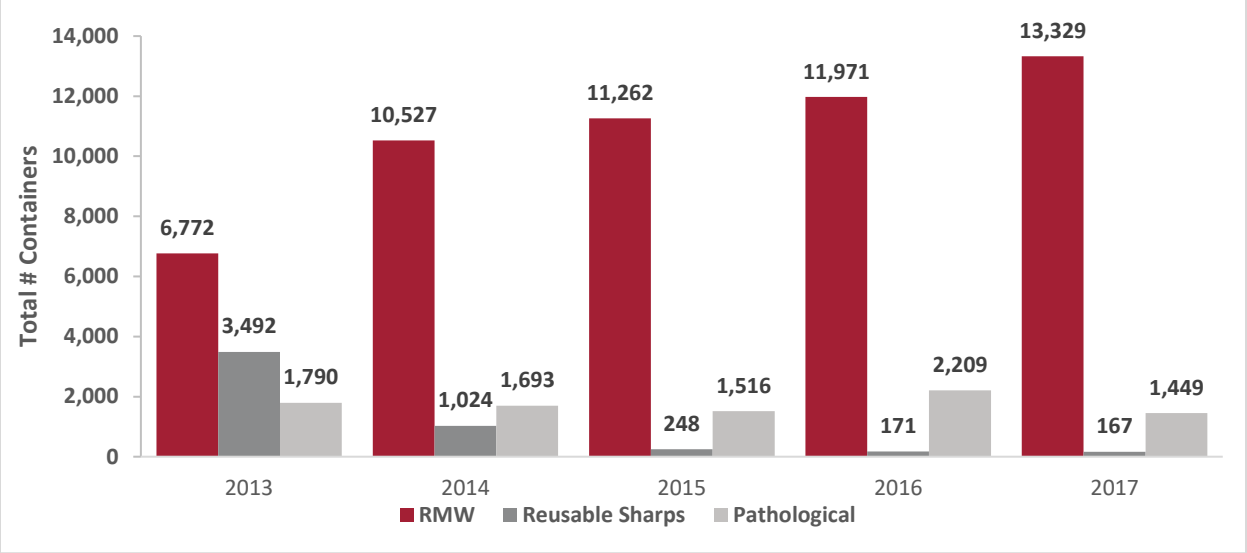
During the past year, the EHS Office continued its strong collaboration and service to the Academy through its interactions with faculty, post-docs, graduate, and undergraduate students and staff. We also collaborated closely with other administrative offices; particularly the Department of Facilities (DOF), the Division of Student Life (DSL), Office of Sponsored Research, Sourcing and Procurement, Office of General Counsel, Office of Emergency Management & Business Continuity, Office of Risk Management, Office of Major Agreements and IS&T to support their efforts to meet the Institute's mission.

Waste Management Program

Regulated Medical Waste (RMW): EHS continued the successful implementation of the RMW management system with the program extending to all DLCs generating biologically contaminated waste. There was a 13% increase in the number of requests for waste collection from the labs. The number of bio-burn boxes collected and shipped for disposal was 13,239. The pathological waste burn-boxes generated by DCM decreased by 65%. The number of reusable sharps containers disposed was 167. All RMW is shipped via our licensed broker Stericylce for processing and final disposal. Most RMW waste is currently disposed in a waste-to-energy facility in Milbury, MA. We are working with our supplier to increase the amount of RMW that can be transformed into reusable plastic. We will be eliminating the use of cardboard "burn boxes" in FY 2018 and replacing them with recyclable plastic containers.

The global implementation of RMW management practices continues to reduce disposal costs, eliminates approximately 12,000 autoclave cycles per year for in-house waste processing, reduces autoclave maintenance costs for DLCs, and eliminates the time by researcher's autoclaving their waste. The program continues to be well received by the departments, labs, and centers (DLCs).

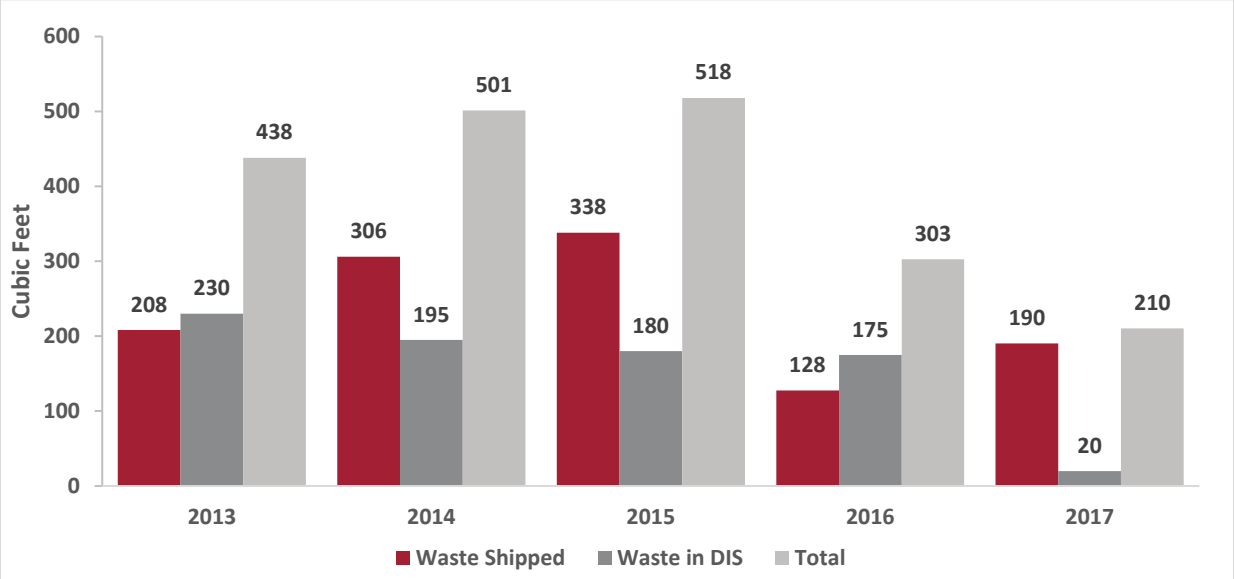
Figure 1. Regulated Medical Waste Disposal FY 2013-2017



Note: The chart above represents all forms of biological waste that has been shipped off-site for proper disposal for the last five years.

Radioactive Waste: The Radiation Protection Program continued to collect and process low level radioactive waste collected from radiation laboratories. The total waste managed has remained constant this past year (*See figure 2*). Approximately 99% of the waste sent offsite for thermal treatment results in no offsite disposal volume for the Institute.

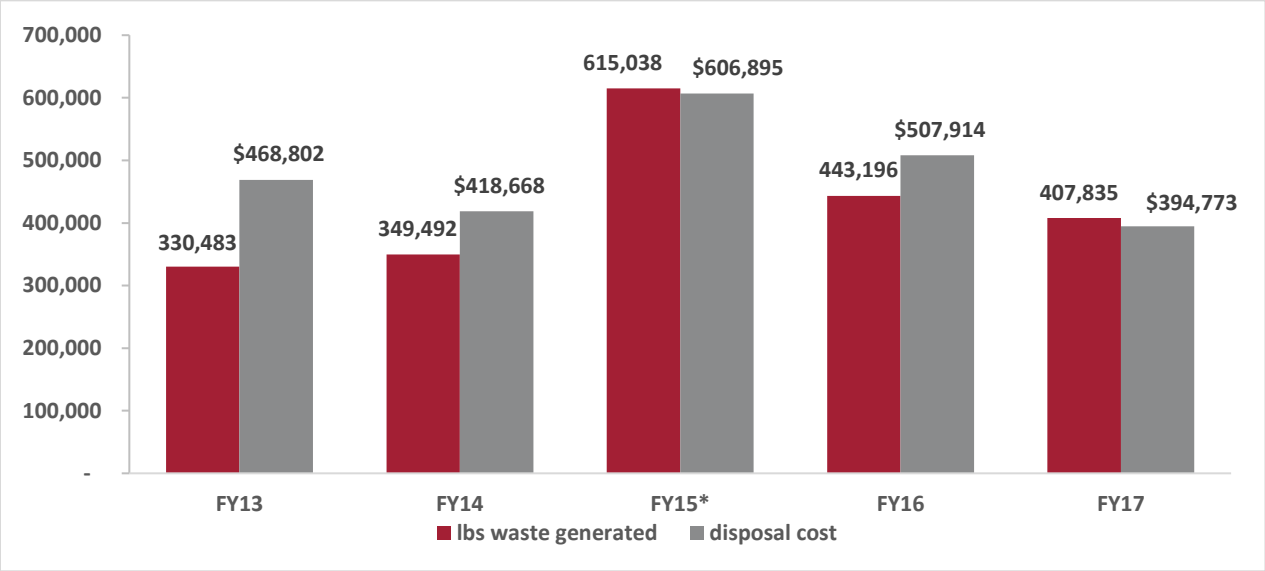
Figure 2. Radioactive Waste Disposal FY 2013-2017



Note: Units are cubic feet. The chart above represents the total low level radioactive waste (LLRW) volumes collected and disposed over the past five years. The LLRW shipped represents dry active waste and liquid scintillation waste contaminated with long half lived radionuclides. The decay-in-storage (DIS) waste represents dry active waste and radioactive sharps that were contaminated with short half lived radionuclides and were managed in-house.

Hazardous Chemical Waste: Hazardous waste volumes stayed relatively constant the past five years even with the increase in research and chemical use. The cost of waste as expressed in $ per pound of waste disposed was reduced from $1.42 in FY 2013 to $0.97 in FY 2017. This was a result in changes in operational procedures and consolidation methods. The team worked with Regulated Medical Waste team to divert chemical sharps which reduce the overall amount of waste. In addition the team re-categorize the waste generated to better represent the types which lead to the minimization of some streams. Finally, the more waste collected the overall cost decreases.

Figure 3. Hazardous Chemical Waste Disposal Spending & Waste Generated



Note: FY 2015 totals include MIT.nano associated waste costs and weight; 12% increase in campus waste.

Training

Development and delivery of EHS training is a major effort both as a regulatory requirement but more importantly as a risk reduction leading indicator. Four (4) new web courses were developed in FY 2017:

1.) Hazard Communication for Shops;
2.) Hot Work Introduction;
3.) Radiation Safety; and
4.) EHS Rep Orientation.

This brings our total web-based courses to 26. In FY 2018, we plan to add at least three more web-based courses. Online courses allow our researchers more flexibility to complete the regulatory required training and serve as a refresher if needed since they can access at any time.

Overall EHS Training Metrics

90% is a good indicator demonstrating high performance due to the limitation of the Learning Management System and we believe all individuals who require EHS training to comply with regulations have completed their requirements.

Some trends in EHS training are:

- Average EHS classroom attendance for FY 2017: **11.6 students** compared to 20 in FY 2016 and FY 2015, 21 in FY 2014 and 19 in FY 2013. This is a metric we use to measure efficiency of delivery but also demonstrates our ability to deliver "just-in-time" training for one or two people so as not to delay their research.
- Total training seats for our core courses has remained relatively stable but our overall training seats (37,613) have increased by 7% as we have added some new courses and conducted outreach to potential users of some of our more narrowly focused courses.
- Estimated Time spent on classroom sessions by EHS Staff: 1,349 sessions x 3 hours/class = 4,047 hours; 4,047 training hours/1,920 hrs/FTE **= 2.04 FTE** in FY 2017
- **28% percent of EHS sessions were web delivered in FY 2017** (average for last three years is 30%).
- DCM conducts specific EHS training not reflected in this data. In FY 2017, they had 1,484 on-line training and 4,388 classroom training completed.
- The percent completion for PIs is lower than 90% for managing hazardous waste because in many cases PIs do not actively manage work in the lab and technically do not require training but 98% of PIs have taken the course at least once.

Table 2. Training completion rate for common EHS courses over the past five years.

Course	Completion Rate FY 2013 (Total trainees)	Completion Rate FY 2014 (Total trainees)	Completion Rate FY 2015 (Total Trainees)	Completion Rate FY 2016 (Total Trainees)	Completion Rate FY 2017 (Total Trainees*)
How Many First Time Trainees	1,683	1,904	2,025	1,953	1,900
General Chemical Hygiene and Hazard Communication	97% (5,741)	97% (5,243)	98% (5,728)	98% (5,684)	98% (4,825)
Lab Specific Chemical Hygiene and Hazard Communication	84% (3,236)	85% (3,592)	85% (3,241)	86% (3,282)	83% (3,400)
DLC Lab Specific Training	87% (1,825)	88% (1,508)	87% (1,803)	88% (1,693)	92% (1,054)
Bloodborne Pathogens	92% (1,298)	93% (1,220)	92% (1,292)	91% (1,336)	88% (1,323)
General Biosafety	99% (2,806)	97% (3,111)	98% (2,814)	98% (2,883)	98% (2,747)
Radiation Safety	95% (767)	95% (765)	94% (638)	95% (601)	91% (601)
Laser Safety	96% (1,651)	94% (1,364)	95% (1,535)	93% (1,530)	93% (1,172)
Managing Hazardous Waste	87% (5,219)	89% (5,210)	90% (5,115)	87.5% (4,908)	85% (3,988)
% PI's Completed Haz. Waste Training	67% (316)	77% (326)	73% (325)	76% (321)	67% (305)
Total EHS web and classroom (Includes LL)	25,553	29,050	29,883	31,860	33,645

Note: Total Trainees are based on self-selection, individuals self-identify their activities via the EHS Training System. The data includes individuals who may have not reviewed their activity selection thus no longer requiring the training.

Injury and Illness Report

Incident Reporting and Investigations

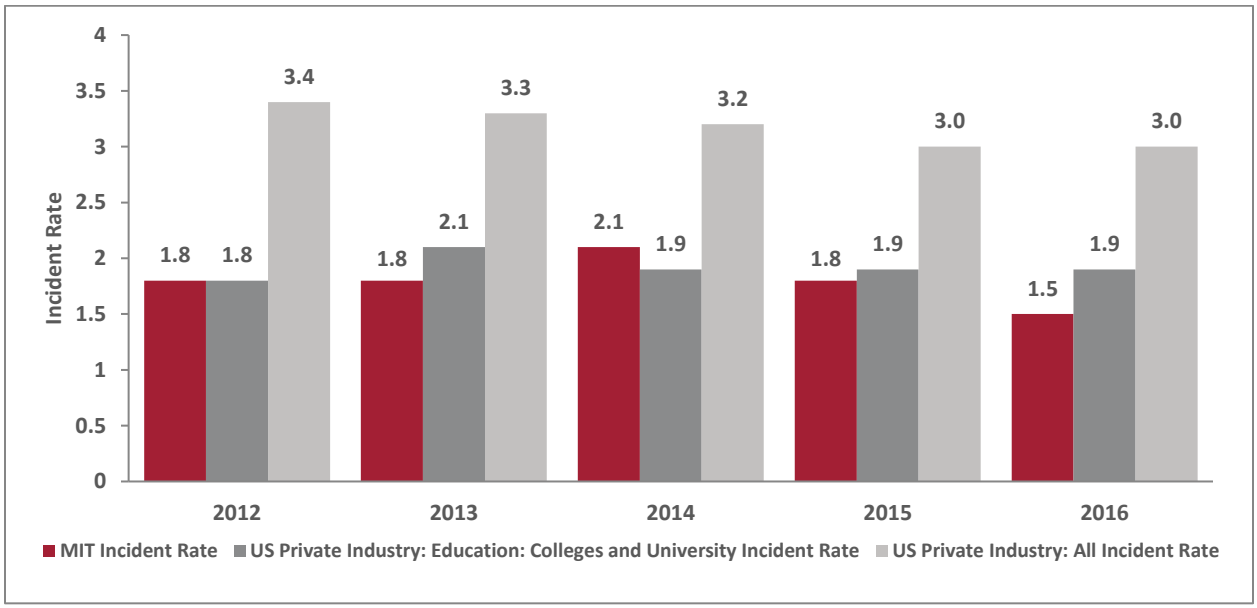
The EHS Office works with MIT Departments, Labs and Centers (DLCs) to use the incident reporting and investigation system, which centralizes and electronically links all information

related to an incident and provides online access to report injuries to Department of Facilities Management, EHS staff, and DLC EHS Coordinators.

As of January 1, 2015 OSHA updated the recordkeeping rule so that in addition to work related fatalities, employers are required to report all work-related inpatient hospitalizations of one or more employees, all work-related amputations and all work-related losses of an eye. In CY 2016 there were three cases where the EHS Office needed to report to OSHA. All cases involved employees who were hospitalized as inpatients overnight.

The incidence rate of total recordable injury and illness cases for calendar year 2016 (1.5) is shown in Figure 4, along with data for the previous four years. This rate is **below** the CY 2016 (latest available data) incidence rate for Private Industry: Education: Colleges and Universities (1.9) and all US private industry rate (3.2) The CY 2016 incident rate is also below the CY 2015 MIT incident rate reported last year and continues a three year trend in reduction. The OSHA recordable incident rate describes the number of employees per 100 full-time employees that have been involved in a recordable injury or illness.

Figure 4. OSHA Recordable Incident Rates of Recordable Injuries and Illnesses



Note: The 2016 US Private Industry Rates, All and Education – Colleges and University, is the 2015 Rates as this is the most recent data. The incidence rate of injuries and illnesses is computed from the following formula: Number of injuries and illnesses X 200,000)/ Employee hours worked = Incidence rate. The 200,000 hours in the formula represents the equivalent of 100 employees working 40 hours per week, 50 weeks per year, and provides the standard base for the incidence rates.

Table 3. The following table is a peer review of MIT's CY 2016 injury/illness data compared to the latest Bureau of Labor Statistics data (CY 2015).

Case Type	MIT	Universities, All U.S.	Private Industry, All U.S.
Total Rate: Total recordable injury and illness cases	1.5	1.9	3.0
Days Away Rate: Cases involving days away from work	0.8	0.5	0.9
Job Transfer/Restriction Rate: Cases involving job transfer or restricted work activity	0.2	0.3	0.7
DART Rate: Total cases involving days away from work, days of restricted work activity, and/or job transfer	0.9	0.7	1.6

Following is a breakdown of the top five most commonly recorded incidents at MIT in CY 2016:

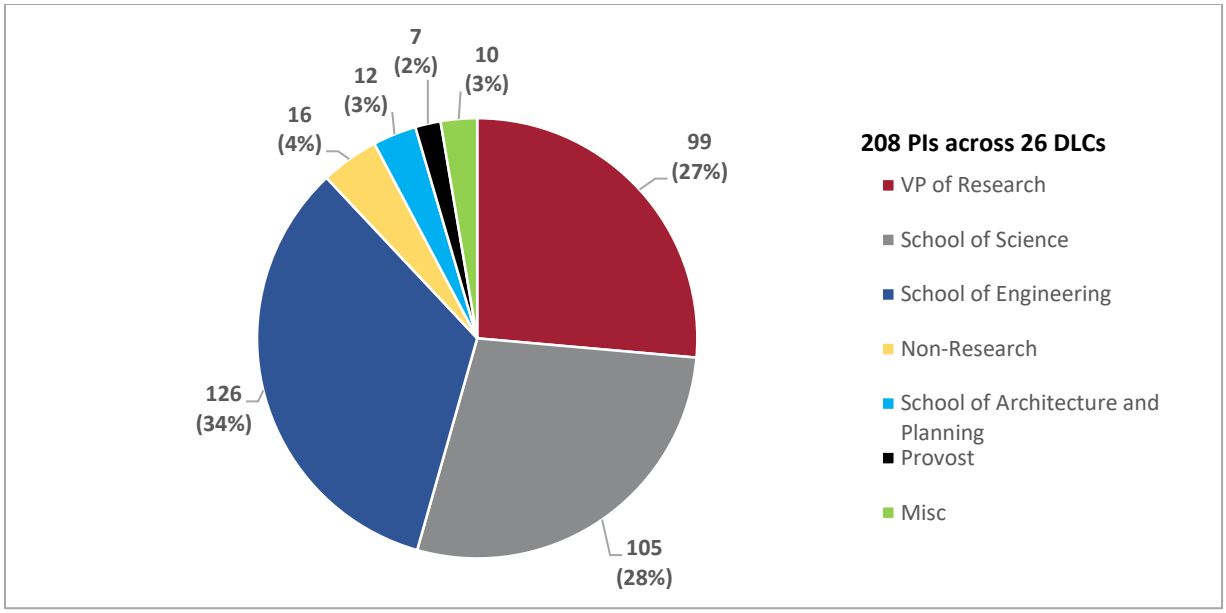
29% - Overexertion in carrying, lifting, pushing, or pulling objects (49)
15% - Falls (to lower level stairs and ladders) (26)
12% - Struck against or by an object (22)
7% - Repetitive motion (13)
7% - Rubbed or abraded by object being handled (13)

Radiation and Biosafety Interaction Across DLC's

Much of our oversight program is built upon the relationship between EHS staff, the PIs and their lab groups. We meet with PIs to discuss their research and the risks inherent in the work and procedures, to assist with registrations, to conduct live trainings at their lab group meetings, and to inspect and just visit the laboratories. Our intent is to remain a highly visible and easily approachable resource for researchers.

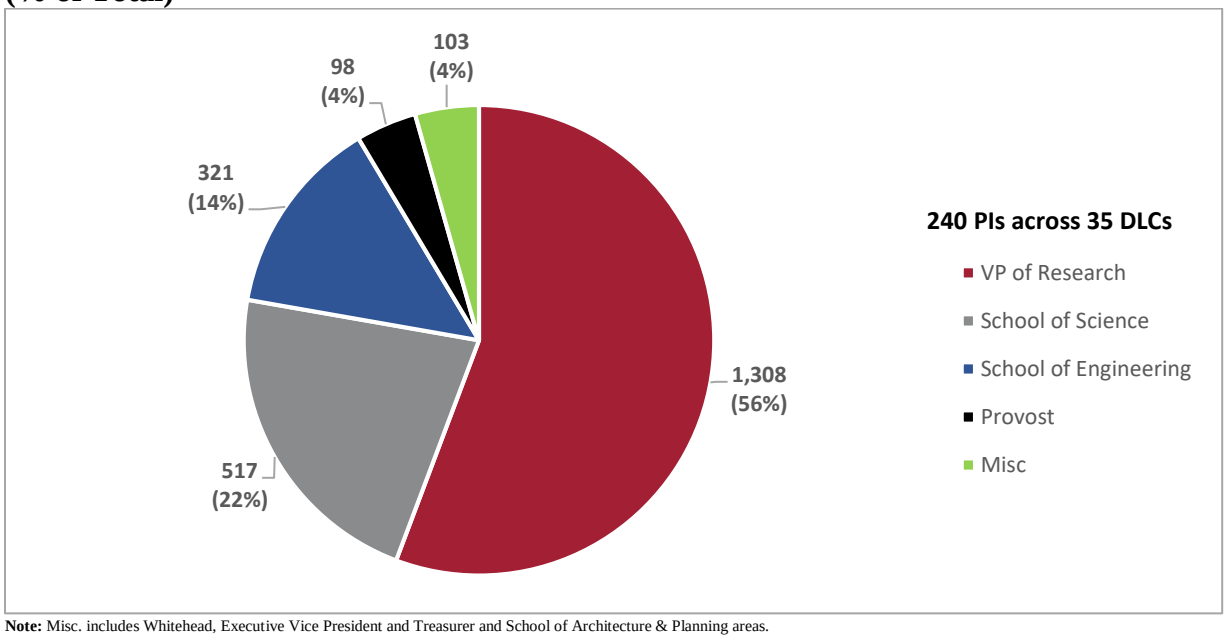
Figure 5a. and 5b. shows the percent of biological research registrations, exposure control plans, laser registrations and radioactive material authorizations by school/area.

Figure 5a. Biological Research Registrations and Exposure Control Plans by School/Area (% of Total)



Note: Non-Research includes exposure control plans from MIT Police, Housing, Facilities, Endicott House, EHS, DAPER, Property Office, CAC, Medical, Division of Comparative Medicine, Koch Institute and Lincoln Laboratory. Misc. includes Dean of Undergraduate Education, Executive Vice President and Treasurer and Provost Areas.

Figure 5b. Radioactive Material Authorizations and Laser Registrations by School/Area (% of Total)



Note: Misc. includes Whitehead, Executive Vice President and Treasurer and School of Architecture & Planning areas.

Research Using Biological Material

Increase in Biological Research at MIT

Over the last five years there has been continued growth in the number of faculty engaged in biological research and participating in the Biosafety Program (BSP) and Committee on Assessment Biohazards/Embryonic Stem Cell Research Oversight (CAB/ESCRO) program at MIT. This growth is a reflection of the increased funding in biological research, the fundamental applicability of the ongoing MIT bioresearch, and the use of new technologies in life science research at MIT.

Table 4. Biological registrations and exposure control plans reviewed by the Biosafety Program

Type	Details
Biological research registrations (BRR)	• 243 biological research registrations reviewed by the CAB/ESCRO (218 active registrations and 25 have been temporarily put on hold). • Many active BRRs are in departments that are not traditionally associated with biological research (e.g. Chemistry (15), Mechanical Engineering (9), Civil and Environmental Engineering (8), Media Lab (7), Electrical Engineering & Computer Science(6)). • Complexity of registrations increases over time with laboratories entering into multi-disciplinary approaches to biological research.
Exposure control plans (ECP) for bloodborne pathogens	• 137 ECPs associated with biological research (e.g. Koch Institute, Biological Engineering, Biology). • 15 ECPs are non-research for employees are expected to be in contact with blood (e.g. MIT Medical, MIT Police Department, Department of Facilities, EHS).

Another indication of the shift in biological research is the shift in the containment level of the biological research at MIT. The number of Biological Research Registrations (BRRs) considered as research requiring BSL1 containment measures has dropped as a percentage of the reviewed and approved registrations over the last 19 years. Approximately 77% of the biological research conducted at MIT required BSL2 or BSL2+, higher containment levels; this is likely due to the large number of laboratories that use human materials but also to the increase in laboratories using various viral vectors, bacteria and/or viruses.

CAB/ESCRO Oversight Program

Recent changes to NIH Guidelines: As of April 2013 the NIH Guidelines have been amended to extend the purview of all (Institutional Biosafety Committees) IBCs to include responsibility for oversight of research involving synthetic nucleic acids. This is because of the fast growing nature of the research involving synthetic nucleic acids, the high dual use potential of this particular area of research, and that prior to this change this research was not within the scope of any federally mandated committee. The Biosafety Program brought synthetic nucleic acid research into the CAB/ESCRO review and approval process some ten years ago; well before the

regulations required it. The change in the regulations did not necessitate any changes in our oversight program.

OSP Collaboration on Human Embryonic Stem (hES) and Induced Pluripotent Stem (iPS) Cell Based Research

The Biosafety Program (BSP) within EHS has effective collaboration with the OSP to ensure that copies of all CAB/ESCRO approval letters for use of hES cells are sent to OSP as needed. BSP also includes OSP on state and federal assurance letters. Beyond the need to ensure appropriate funding for hES and iPS cell research, access to the OSP grants database is helpful in understanding future areas of research growth.

Co-ordination of Research Compliance: the CAB/ESCRO, CAC, and COUHES

All three committees carry federal level oversight documentation responsibilities; provide assurances to different agencies and must be registered with those agencies. Their compliance programs involve approvals with various levels of review depending on risk. In several instances, there is overlap in committee responsibilities.

The Biosafety Program Deputy Director is the only person who is a voting member of all three committees and as a voting member reviews all research protocols for all three committees. This amounts to review of several thousand protocols per year. It has allowed the Deputy Director to identify overlap areas and work with the various committees to have one take primary responsibility for oversight with the other committees developing mutually supporting policies.

Trends in Biological Research

The recent trends of non-microbiologists working with biological materials has continued to increase. The newest trend in biological research of the past fiscal year is an increase in artists wanting to perform wet lab procedures in biology and microbiology. These projects, while generally on the lower end of the spectrum when it comes to biohazards, do present a challenge in that most of these groups are not equipped to perform this work, have little or no previous experience or training in the techniques, and almost all are developed with the goal of public exhibition.

To address some of these challenges, BSP has made efforts to connect artists with trained researchers in order to build collaborations that offer laboratory space as well as mentorship in development of the project and performance of laboratory techniques. Most research groups utilize their laboratory space to full capacity; however, and it is often difficult to find laboratories that are willing to share precious space, especially if the research goals are not clearly aligned.

One continuing trend on campus is the establishment of Maker spaces where the MIT community can register to gain access to specialized equipment with which they can test creative ideas. During the past year, the Biosafety Program assisted the department of Biological Engineering (BE) in creating a new Biomaker Space on campus. This new project is akin to the many other Maker spaces on campus where participants are allowed to develop their own project

in a safe environment where members and supervisors promote a strong culture of safety. We expect other Biomaker spaces to be created on campus in the near future and to facilitate the expansion of these collaborative environments, the Biosafety Program sought suggestions and feedback from stakeholders such as the teaching instructors that work in the BE Biomaker space, Drs. Martin Culpepper and David Kong (from Mechanical Engineering and the Media Lab, respectively) to develop an accessible policy document approved by the CAB/ESCRO that describes the responsibilities of DLCs, PIs, Supervisors and participants for Biomaker spaces.

While this meets the challenge of research groups needing to the find the appropriate space to perform their work safety, it still leaves the challenge of how to ensure that these researchers have the correct level of training to utilize their new labs. In situations where building their own lab is not feasible, BSP has offered our laboratory space in N52 for short term projects where containment is suitable. They receive hands on training from BSP staff as needed in addition to all formal EHS training courses and lab-specific training. Development of programs to help train non-traditional wet lab researcher will be needed to meet this meeting of disciplines in the future.

Public exhibition of biological projects adds another layer of risk assessment in these situations. Exhibition requires transport of materials, of lab-like environments outside of the laboratory, and the introduction of a new population (the public) that is less tightly controlled. Risk assessments for the few instances of public exhibition have included a case-by-case analysis of risks and what might possibly go wrong. MIT Medical Occupational Health and General Counsel are consulted as necessary. Future development of laboratories with glass walls or windows that allow for viewing of projects without their transport or direct interaction with public may be a design consideration to incorporate in these circumstances.

Research Using Radiation Producing Materials and Equipment

During the past year, the Campus, Bates, and Reactor Radiation Protection Programs (RPP) continued their strong presence in the academy with the continued implementation of numerous service programs and interactions with faculty, post-docs, students, and staff. RPP staff performed radiation hazard risk analysis for proposed and continuing uses of licensed material and machine produced radiation in RPP ongoing programs for (a) radioactive materials authorization, (b) analytical x-ray machine registration, (c) accelerator review and registration, (d) experimental use and operations of the MIT research reactor, (e) laser registration/safety, (f) super conducting magnet registration /safety, and (g) RF source registration/safety. The demand for RPP services remained strong with a continued increase for experimental reviews involving higher powered laser and RF sources at the Lincoln Laboratory and Haystack/Millstone Hill and the routine and non-routine outages at the nuclear reactor.

The Koch Institute (KI) Positron Emission Tomography (PET) facility and radiochemistry lab use continues to expand. There are now 6 authorized projects performing PET research. The use of the facility is expected to continue to expand with new experimental protocols and use of additional new PET isotopes. RP staff have re-established the iodination facility in building 68 in anticipation of proposed iodination experiments and the possibility of obtaining a second PET scanner.

There was a continued increase in the use of high energy accelerators in several northwest campus facilities with the addition of a new cyclotron and one new accelerator during the past year. RPP worked closely the Nuclear Science and Engineering (NSE)/Plasma Science and Fusion Center (PSFC) staff to design and install a new search and security system for the NW13 basement accelerator facility in anticipation of the new cyclotron. RP staff worked closely with NSE faculty and students to characterize the radiation fields from the new Center for Science and Technology with Accelerators and Radiation (CSTAR) cyclotron. In preparation for the proposed Soonest/Smallest Private-Funded Affordable Robust Compact Reactor (SPARC) project, RPP worked closely with the NSE/PSFC staff to monitor for free release all of the cement block shielding in the NW21 west experimental hall in preparation for the super conducting magnet development/manufacturing facility portion of the SPARC project. RP staff attended several meetings with SPARC project faculty to discuss the radiation safety requirements for this project. The SPARC project team updated the RPC during their quarterly meeting.

RPP implemented the updated/revised Accelerator Safety Program. There are currently nine (9) accelerators on campus and two (2) at Bates. The accelerator facility in the basement of NW13 is a great resource for the institute and the RPP continues to work closely with them as they enhance the safety systems including interlock controls and active radiation monitoring systems. MIT continues to have three (3) geographical locations designated for accelerator facilities; Bates, Building N10, and Buildings NW13-21. The annual registration fee per location is $9,000. This registration system continues to save MIT 24,000 per year.

RPP implemented the new MRCP regulatory requirements for the security requirements for the four (4) irradiator facilities on campus. The regulatory requirements are physical security to detect unauthorized access, established emergency response procedures, and qualification of users as trustworthy and reliable. The security program is a collaborative effort between MIT Police, IS&T, Facilities Operations Center, and RPP (lead). The emergency response component of the program also involves the Cambridge Police and Cambridge Fire Departments. The new regulatory requirements include an annual review and of the security program by the MIT Police Chief and RPO, an annual meeting with the Cambridge Police and Fire Departments to review emergency response protocols, annual retraining for all irradiator facility users, and a ten year re-evaluation of users criminal background history including fingerprinting. The functionality of the upgraded security systems for our irradiator facilities are audited on a quarterly frequency. RPP assumed the quarterly security and alarm testing program for the gamma irradiator facilities. RPP works in collaboration with the MIT Police, IS&T, and Facilities Operations Center to manage/test these secure facilities. MIT Police received their required annual retraining on the irradiator security system and emergency response procedures.

Bates Reconfiguration: As part of its agreement with Department of Energy (DOE), MIT Bates continued its clean-up of those accelerator systems not required for the future Bates mission. After receiving bids exceeding $500,000 to estimate costs for developing a decommissioning strategy, Bates leadership and RRP agreed to collaborate on a review of remaining issues and develop a strategy employing internal resources. In 2016 RPP managed an effort to disassemble one of 16 activated dipoles located in the storage ring area to determine the feasibility of reducing the amount of activated materials by separating activated from non-activated

components. This effort required considering both radiation safety and asbestos control (ACM) issues. Based on a successful result, it was concluded future disposal options for the remaining dipoles located within the storage ring and the BSY could include disassembly and holding activated components for long term storage.

RPP continues to work with community liaisons to provide radiation safety and emergency response training to the Cambridge Police and Fire Departments as requested. In an effort to reduce the risks to MIT grounds staff from the improper disposal of hypodermic needles, we installed a needle collection receptacle at the Cambridge and Somerville Program for Alcoholism and Drug Abuse Rehabilitation (CASPAR) facility on Albany Street. To date we have been removing approximately 35-40 needles on a bi-monthly frequency from this repository which reduces the risk of a needle stick to our grounds workers.

Table 5. Data reflecting the uses of radiation sources at MIT and its off-campus sites, which require MRCP registration and approval.

Radiation Source/Equipment Program	Current number	RPP requirements
Radioactive material authorizations	116	New or biennial review, risk assessment, audit with approval by the RPC. Protocol amendments during renewal periods.
Generally licensed registrations	10	One time registration with RPP until source disposal.
Generally Licensed sources (LL)	278	Registration with RPP. Leased sources require annual exchange with vendor.
Irradiator registration	34	Registration with RPP and annual review
Analytical X-ray machines	46	Registration with RPP, MRCP, and annual safety review
Medical/dental X-ray machines	6	Registration with MRCP and annual safety review
Accelerators	12	Registration with RPP, MRCP and annual safety review
Lasers (Class 3b and Class 4)	1,450	Registration with RPP, MRCP and annual safety review
RF Sources	30	Registration with RPP and annual safety review
Magnets	40	Registration with RPP and annual safety review

Note: Authorizations and approvals require a risk assessment, experimental review, completions of radiation safety training and routine inspections by the RPP.

The Massachusetts Radiation Control Program (MRCP) conducted three (3) unannounced regulatory inspections at MIT during the past year. On November 14, 15, and 17 and December 21, 2016, MRCP staff inspected all activities authorized under our broad license # 60-0094. The previous inspection was in 2013. The inspectors reviewed activities on campus, Bates, and Lincoln Lab. There were no items of non-compliance. During this inspection, the MRCP also inspected our security and emergency response programs associated with our irradiator facilities. The inspectors reviewed our implementation of the new regulations that were going into effect in January 2017. There were no items of non-compliance. In October, the MRCP conducted an accelerator inspection at our Bates campus. There were no items of non-compliance.

Major EHS Initiatives for FY 2018

1. Re-assess the EHS-MS organizational structure for non-academic departments starting with Facilities.
2. Collaborate with Facilities to implement the Institute's Laboratory Wastewater Master Plan.
3. Increase EHS efficiency and productivity by upgrading our technology.
4. Review and Assessment of the EHS-MS with respect to the APLU report.
5. Support the dramatic increase in design and construction projects.
6. Complete roll out of the eShipGlobal Program.
7. Continue the roll out the Chemical Inventory Program.
8. Increase support to Lincoln Laboratory and other offsite facilities.
9. Develop new and update existing EHS training courses.
10. Developing and communicating standard operating procedures; this includes streamlining existing documents and developing new laboratory safety procedures.
11. Assess EHS requirements for international campus activities.
12. Develop talent management roadmaps to support our staff's professional development.
13. Develop new initiatives to enhance and add to MIT's culture of safety.
14. Develop capability to develop new ideas and innovate present EHS programs.
15. Continue and expand engagement with groups who have similar responsibilities within the DLC's including machine shop supervisors, laboratory managers, facility managers, DLC EHS representatives, and student groups.
16. Develop and implement an Unmanned Aerial Vehicle Program.
17. Assist the Academy in expanding the Makerspace Program.
18. Investigate the risk of field work conducted by MIT personnel.
19. Collaborate with the Office of Emergency Management to enhance the Emergency Preparedness & Response Program.
20. Continue to work with the NSE Faculty on the planning for the **SPARC** project.

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More information about the Environment, Health, and Safety Office can be found at http://ehs.mit.edu/.