Environment, Health, and Safety Office

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 the operation of MIT's endeavors in Cambridge, at Lincoln Laboratory, and worldwide.

To reduce the risks inherent to new and innovative research, EHS must be able to guide the Institute in early risk assessments to embed mitigation practices and designs into research proposals and to ensure that appropriate safeguards are present in spaces where work is conducted. EHS programs have helped to identify predictive indicators that mean the Institute could be put at risk if the research being assessed is not done carefully, with safety considered in the planning stages.

Over the past few years, there have been significant increases in battery research, which typically uses highly reactive and energetic materials, and in the conversion of traditional machine shops to digital fabrication studios (so-called makerspaces), which present new types of hazards to shop users. The use of unmanned aerial vehicles (drones) has also increased and the fields of nanotechnology and synthetic biology have seen substantial growth. EHS expects advances in both autonomous underwater vehicles and on-road, off-road vehicles that will require assessment of the hazards and risks imposed.

EHS has a history of planning for safety by following the scientific literature, tracking funding sources and the research trends, interacting with EHS's peers, and interacting with MIT's leading faculty members. More recent trends have seen engineering moving into the biological sciences, an increase in unmanned vehicles, and undergraduate students conducting more hands-on activities with hazardous materials and equipment (in makerspaces and through the Undergraduate Research Opportunities Program). This requires EHS to reevaluate the design requirements for engineering facilities and for the training needs of engineers and students. The possibility that The Engine will operate on campus presents 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 this aspect is often not explicit. The importance of a strong culture supporting safety 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 (DLC) leaders to achieving a high awareness of safety and caring.

Faculty Members' and Principal Investigators' Responsibilities

In fiscal year 2011, EHS began to conduct orientation sessions for new faculty members and principal investigators (PIs). This effort has been expanded to include a presentation and discussion session for all faculty in an effort to help faculty both understand

their EHS responsibilities and become aware of the resources available to assist them. EHS's orientation takes place at either departmental faculty meetings or at one-on-one meetings. Although orientation is not a regulatory requirement, 182 out of 459 PIs who work with hazards have completed it. This is a completion rate of 40%. In FY2018, EHS plans to continue this outreach as part of the safety culture initiative.

Emergency Preparedness Planning

In FY2015, EHS made significant strides, verifying that approximately 95% of the DLCs have a completed emergency preparedness plan (EPP). EHS applied a model for all-hazards emergency preparedness plans to be used by DLCs across the Institute in collaboration with the Office of Emergency Management & Business Continuity. EHS used an all-hazards emergency preparedness plan template that consolidated evacuation procedures, communications protocols, shelter-in-place measures, and Occupational Safety and Health Administration (OSHA) fire prevention requirements into a five-worksheet Excel document. In FY2017, EHS collaborated with the Office of Emergency Management and Business Continuity to develop appropriate training and systems to update EPPs across MIT.

Makerspaces

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

EHS is 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 EHS is preparing for expansion into other areas, such as radiation.

Comprehensive Laboratory Hazard Assessment

An Association of Public Land Grant Universities report issued this year identified the lack of a comprehensive hazard assessment before a procedure was started as a causal factor of tragic incidents that have occurred in universities in recent years. Several current programs assess a specific hazard in a laboratory or register or document conditions in the laboratory. However, there is no comprehensive assessment of each laboratory that uses 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 laboratory hazard assessment pilot program started in FY2013 was expanded in subsequent years. EHS has conducted laboratory hazard assessment in more than 70 PI groups in 12 DLCs to date.

International Agreements

EHS made a major effort this year to support the Singapore–MIT Alliance for Research and Technology (SMART) agreement. Support for SMART focused on implementing the Institute's EHS management system for adoption by SMART and providing technical support for some of the more hazardous operations. EHS participated in an audit of the EHS system that was conducted by the Singapore agency that manages the facility.

In addition, EHS has provided assistance to other MIT collaborators, including the Masdar Institute Cooperative Program, King Fahd University of Petroleum and Minerals, and Singapore University of Technology and Design (SUTD). Further, EHS has advised 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 active in the review of designs for laboratory renovations, for capital improvements to spaces, and for larger capital projects, such as MIT.nano and the complete renovation of Building 31. Involvement in laboratory design enables EHS to assist in building into new and renovated spaces physical features that allow specific safety culture elements to take hold. Laboratory ventilation, hazardous gas monitoring, chemical storage, hazardous waste handling, and wastewater treatment are just some of the areas EHS frequently addresses. Minimizing effects on the community during many construction projects is another area of focus.

In FY2017, Campus Construction and EHS finalized and began to implement the process that is being used to assure adequate EHS support for design review and construction safety. EHS participated in 354 total projects representing more than $1 billion in construction work. Projects ranged from large capital projects to capital renewal, space change, utilities, energy, special projects, and facilities managed by the Comprehensive Stewardship Group, and other projects. Six EHS staff members did most of the contact work (project liaison or construction safety liaison); 24 staff members participated on at least one project. In addition to serving as direct contacts, many technical EHS staff provided support to projects.

Updating the Master Plan for Campus Wastewater

EHS's work with the Office of Campus Planning, Campus Engineering and Construction, and Utilities Operations on the FY2012 Notice of Violation for mercury and the FY2013 Notice of Noncompliance for copper from the Massachusetts Water Resources Authority (MWRA). The future needs of MIT.nano have brought all to agree that a study to update the campus wastewater master plan is necessary, as probable expansion of the system is also likely to be. This is a continuing project begun in FY2015.

Integration of Biological and Radiation 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. Common questionnaires or pre-thought-out formats could enable a laboratory to prepare one set of approval protocols that would satisfy multiple levels of governance.

This year, EHS completed an effort to determine the feasibility of, and barriers to, automating and integrating the process to approve and authorize biological research protocols and the use of radiation in MIT's laboratories. Hundreds of these approvals are now managed each year with a largely manual process that costs laboratory personnel significant time to complete. EHS has selected a vendor (On Site Systems) and several modules of the software (Environmental Health & Safety Assistant) and will conduct a three-month pilot operation in FY2018 to determine the benefits.

Transforming Experiences through Collaboration

eShipGlobal Software Project Pilot

After careful evaluation, EHS believes that eShipGlobal software can simplify the shipping process for the MIT community, reduce overall costs, and enhance compliance in shipping hazardous materials and export controls. This is a collaboration between Procurement, the Office of Sponsored Programs (OSP), several DLCs, and EHS. By the end of FY2017, eight DLCs and 786 users had implemented the system. Goals include increased compliance with the export regulations of the US Department of State and Department of Commerce, and with the hazardous materials regulations of the US Department of Transportation. This will reduce risk to the Institute while simplifying shipping processes and reducing shipping costs.

Chemical Inventory

Since its launch in 2015, 181 laboratory groups have uploaded their chemical inventories into the CISPro Cloud platform provided by EHS. This represents close to half of all the laboratories on campus where chemicals are used. There are also more than 100,000 chemical containers in these laboratory inventories, spread over 23 DLCs.

To support this important EHS initiative, the technology support team has a dedicated staff member to assist new and existing customers. The chemical inventory technologist meets with laboratory members, demonstrates the CISPro Cloud Chemical Inventory software, trains faculty and staff in its use, and provides data upload templates and hands-on data cleaning services. This hands-on user support is a key factor in increasing the use of the central chemical inventory solution at MIT.

During FY2017, the following tasks were accomplished by the chemical inventory staff and program:

- Supported 34 new PI laboratory groups in uploading the CISPro Cloud inventory software;
- Added 114 user logins to the system;
- Helped 70 laboratories to adopt a generic "all laboratory members" login and password;

- Uploaded data on 15,953 new chemical containers, with an additional 3,861 containers added directly to the system;
- Provided more than 90 trainings and software demonstrations to laboratory members to teach them how to use the platform to maintain an inventory or to interest them in using the platform for future inventory management;
- Helped four laboratories take advantage of the opportunity, while uploading their data, to update current inventories; and
- Resulted in 1,186 containers being disposed of by laboratories in the system, while four laboratories removed and replaced 2,262 containers during an upload, clearing out old materials and completely refreshing their inventories.

Outreach

EHS has continued its efforts to reach out to key groups at the Institute, both to communicate emerging EHS issues and to obtain feedback on how best EHS can help the groups maintain safe and healthy conditions and compliance with regulations. The approach is to identify people at the Institute who perform similar functions and have similar EHS challenges and then bring them together periodically to discuss common issues. There are now five groups that meet at least quarterly: machine shop supervisors; laboratory managers; DLCs' EHS coordinators; Department of Facilities Repair and Maintenance; custodial and utilities managers; and DLCs' building or facility managers. These have been very effective in establishing two-way communications and solving difficult problems.

Compliance-Related Activities

The following shows the routine regulatory reports and inspections that were performed in FY2017. EHS is the main liaison with these agencies, accompanying them on inspections and submitting the required reports. In addition, EHS has periodic unannounced inspections each year.

EHS Regulatory Compliance Calendar

July

- Monthly discharge monitoring report (DMR) for National Pollutant Discharge Elimination System (NPDES) permit
- Quarterly submittal of NPDES DMRs for NPDES cooling waste discharge to Charles River
- US Department of Transportation (DOT) hazmat registration
- Massachusetts Department of Environmental Protection (MassDEP) Title V compliance certifications
- MassDEP/EPA NOx Excess Emissions Report
- Testing of samples from the MIT pools for bacterial contaminants

August

- Massachusetts Radiation Control Program (MRCP) license renewal
- Analytical X-Ray registration renewal
- Low-level radioactive waste (LLRW) renewal
- Accelerator registrations renewal
- Monthly DMR for NPDES permit
- Committee on Assessment Biohazards/Embryonic Stem Cell Research Oversight (CAB/ESCRO) meeting

September

- Radiation Protection Committee (RPC) 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
- Cambridge Public Health Department (CPHD) ice skating Rink certificate
- CAB/ESCRO meeting

October

- Monthly DMR for NPDES permit
- Quarterly Submittal of 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

November

- Explosive user certificate

- Nuclear Materials Management and Safeguards System (NMMSS) Reconciliation Report for special nuclear material (SNM) receipt/transfer
- Monthly DMR for NPDES Permit

December

- Site accelerator registration renewal
- Nuclear Regulatory Commission (NRC) inspections
- Reactor Safeguards Committee meeting
- Radiation Protection Committee (RPC) meeting
- Functionality testing of accelerator interlock and security systems
- Functionality testing of radiation protection program (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

- MassDEP Title V compliance certifications
- Review of MIT Security Plan for irradiator facilities with MIT Police Chief
- Review of memorandum of understanding (MOA) with Cambridge Police and Fire departments for irradiator emergency response plans
- Monthly DMR for NPDES permit
- Quarterly submittal of 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

February

- MRCP inspection of Increased Control Security Program
- Low-Level Radioactive Waste Report
- Monthly DMR for NPDES permit
- Occupational Safety and Health Administration (OSHA) 300A log
- OSHA 300 log
- FM Global insurance inspection
- Cambridge biosafety permit renewal
- Report from CAB/ESCRO to the City of Cambridge

March

- Annual laser inventory
- NRC—Calendar Year Annual Report and review of RPP program
- Flammable liquid permits/License renewals
- Annual audit—Bates Linear Accelerator Center
- Superfund Amendments and Reauthorization Act (SARA) Report
- EPA Greenhouse Gas Report
- Radiation Protection Committee (RPC) Meeting
- Functionality testing of accelerator interlock and 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 and Maintenance Report
- Resource Conservation and Recovery Act (RCRA) Report (March 2018)
- CAB/ESCRO meeting

April

- Annual Low-Level Radioactive Waste Report
- MassDEP Source Registration/Emission Statements
- Annual RPP Program audit

- NRC inspections
- Monthly DMR for NPDES permit
- Quarterly Submittal of 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

May

- Annual audit of MIT and Whitehead Institute for Biomedical Research (WIBR) radiation protection programs
- Monthly DMR for NPDES permit

June

- Radiation Protection Committee (RPC) Meeting
- Functionality testing of accelerator interlock and security systems
- Functionality testing of RPP irradiator security systems with MIT Police, Facilities Operations Center, and IS&T
- Monthly DMR for NPDES permit
- MassDEP underground storage tank (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 two years: expected 2019)
- MRCP Inspection of Broad Scope license activities (every three years: expected 2020)
- NRC Special Nuclear Materials Inspection (every five 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 three years; to be renewed in fall 2017)

Laboratory Wastewater Master Plan: Underlying issues concerning compliance with MWRA regulations led to a need for the Department of Facilities and EHS to prepare a scope of work and select a consultant to revise the 2000 Wastewater Master Plan for the Cambridge campus. The revised plan will assess current conditions, define regulatory requirements, and include a draft study and treatment equipment standards and procedures.

Air Emissions: The MIT Cambridge campus has an Air Quality Operating Permit (Title V permit) from the Massachusetts Department of Environmental Protection. The permit is required if the facility is a major source emitter of any criteria pollutant; in this case, the pollutant is nitrogen oxides.

Regulatory Interactions

The Nuclear Regulatory Commission's routine annual inspection resulted in no citations or fines.

Cambridge Inspectional Services conducted a routine annual inspection of campus buildings. EHS and the Department of Facilities are working to correct the 281 findings that were identified in the 250 buildings or spaces inspected. Approximately 95% of the findings were corrected in FY2017.

Accomplishments

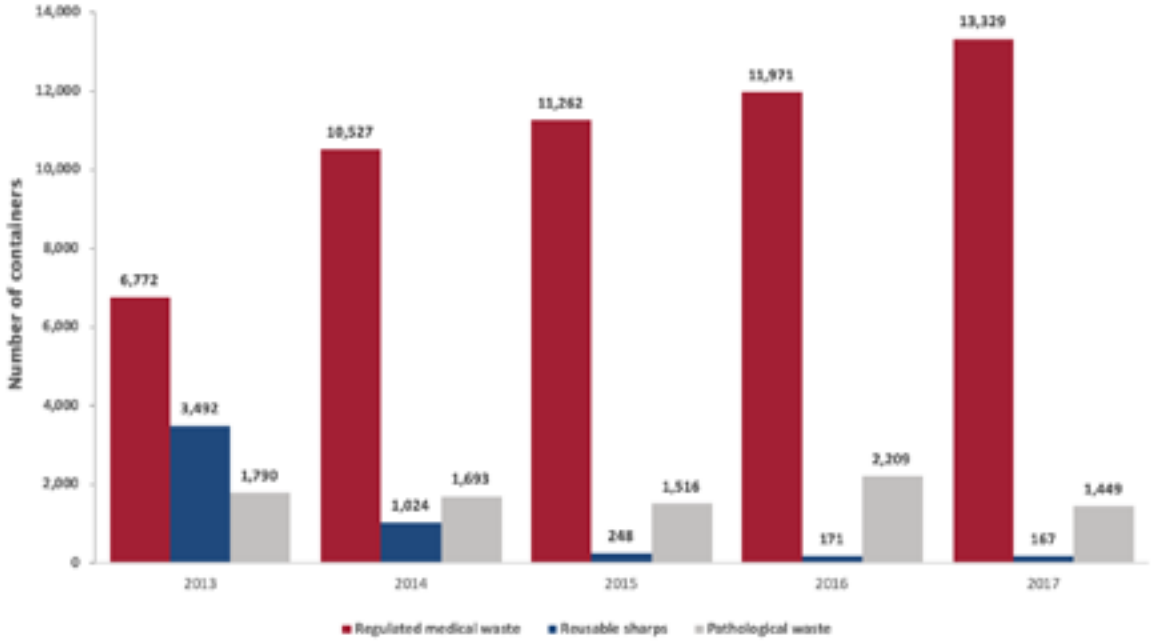
During the past year, EHS continued its strong collaboration with and service to the Institute through its interactions with faculty, postdoctoral associates, graduate and undergraduate students, and staff. EHS also collaborated closely with other administrative offices, particularly the Department of Facilities, the Division of Student Life, OSP, the Office of General Counsel, the Office of Emergency Management and Business Continuity, Sourcing and Procurement, the Office of Risk Management, the Office of Major Agreements, and Information Systems and Technology, to support their efforts to meet the Institute's mission.

Waste Management Program

EHS continued the successful implementation of the regulated medical waste (RMW) management system; the program now extends to all DLCs that generate biologically contaminated waste. There was a 13% increase in the number of requests for waste collection from laboratories. The number of bio-burn boxes collected and shipped for disposal was 13,239. The number of pathological waste burn-boxes generated by the Division of Comparative Medicine decreased by 65%. The number of reusable sharps containers disposed of was 167. All RMW is shipped via MIT's licensed broker Stericycle for processing and final disposal. Most RMW waste is currently disposed of in a waste-to-energy facility in Milbury, MA. EHS is working with a supplier to increase the amount of RMW that can be transformed into reusable plastic. EHS will eliminate the use of cardboard burn-boxes in FY2018 and replace them with recyclable plastic containers.

The global implementation of RMW management practices continues to reduce disposal costs, eliminate approximately 12,000 autoclave cycles per year for in-house waste processing, reduce autoclave maintenance costs for DLCs, and eliminate the time spent by researchers in autoclaving their waste. The program continues to be well received by DLCs.

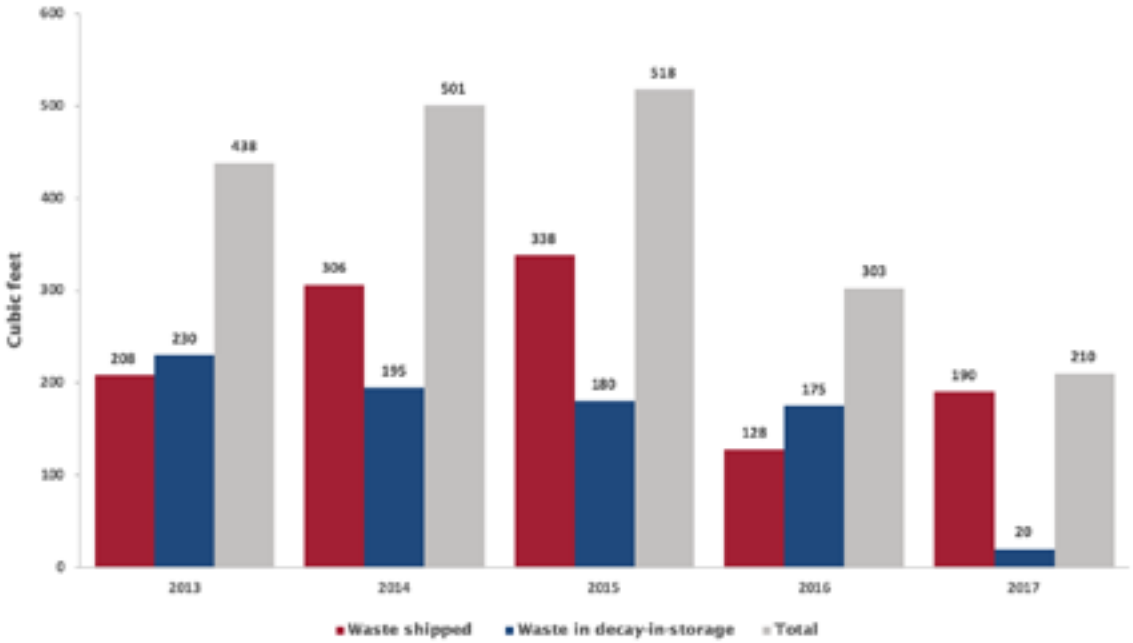
Figure 1. Regulated Medical Waste Disposal FY2013–FY2017



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

The Radiation Protection Program continued to collect and process low-level radioactive waste collected from radiation laboratories (Figure 2). Approximately 99% of the waste sent off-site for thermal treatment resulted in no off-site disposal volume for the Institute.

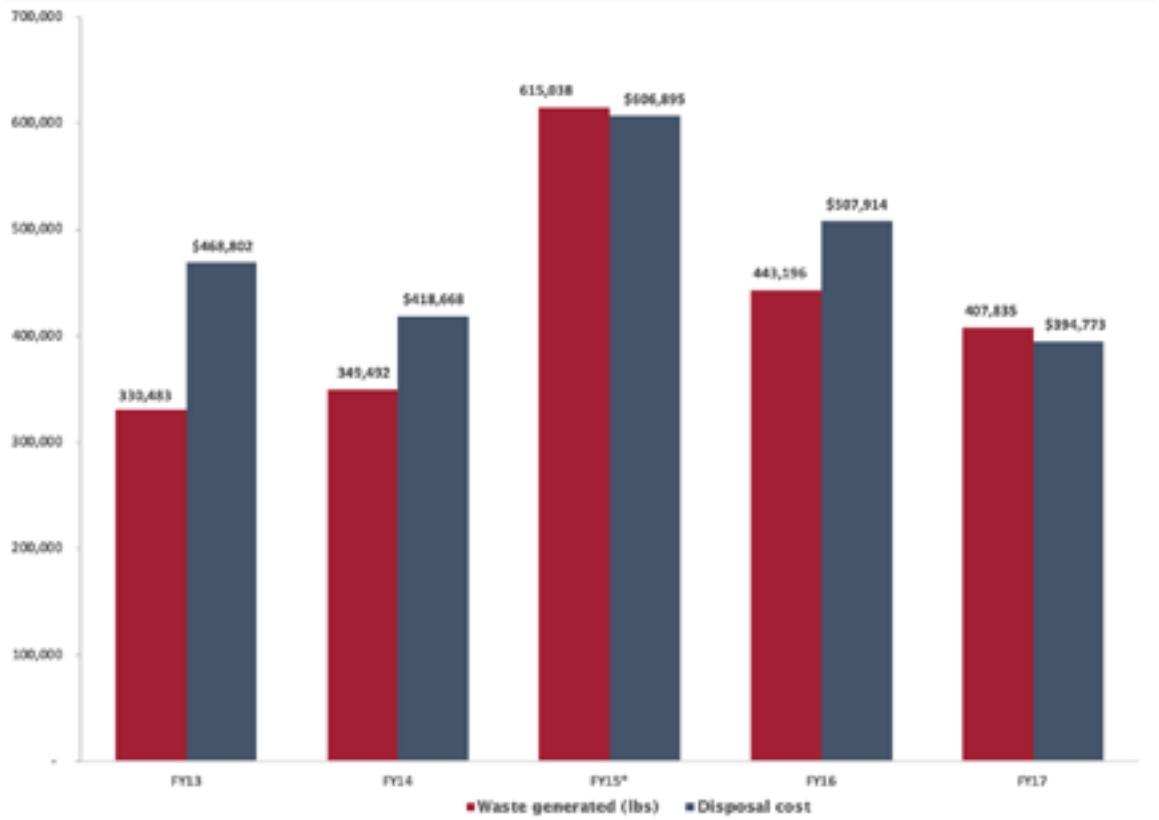
Figure 2. Radioactive Waste Disposal FY2013–FY2017



Note: Units are cubic feet. The chart above represents the total LLRW volumes collected and disposed of 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.

The cost of waste as expressed in dollars per pound of waste disposed was reduced from $1.42 in FY2013 to $0.97 in FY2017. This resulted from changes in operational procedures and consolidation methods. The radioactive waste disposal team worked with the regulated medical waste team to divert chemical sharps, which reduced the overall amount of waste. The teams also re-categorized the waste generated to better represent the types of waste, which led to the minimization of some streams. Finally, as the amount of waste collected rises, the overall cost decreases.

Figure 3. Hazardous Chemical Waste Disposal Spending and Waste Generated



Note: FY2015 totals include MIT.nano–associated waste costs and weight, which meant a 12% increase in campus waste.

Training

Development and delivery of EHS training is a major effort, both to meet regulatory requirements and, more important, to act as a leading indicator of risk reduction. Four new web courses were developed in FY2017:

- Hazard Communication for Shops
- Hot Work Introduction
- Radiation Safety
- EHS Representative Orientation

This brings the number of EHS's web-based courses to 26. In FY2018, EHS plans to add at least three more web-based courses. Online courses allow researchers more flexibility to complete the required regulatory training and easily serve as a refresher if needed, because the courses can be accessed at any time.

Overall EHS Training Metrics

EHS believes that all individuals who require EHS training to comply with regulations have completed their requirements. Ninety percent is a good indicator demonstrating high performance due to the limitation of the Learning Management System.

Some recent figures and trends in EHS training are:

- Average EHS classroom attendance for FY2017: 11.6 students, compared with 20 in FY2016 and FY2015, 21 in FY2014, and 19 in FY2013. Average classroom attendance is a metric EHS uses to measure efficiency of delivery, but it also demonstrates the ability to deliver "just-in-time" training for one or two people so as not to delay their research.
- The number of total training seats for EHS core courses has remained relatively stable, but the number of overall training seats (37,613) increased by 7%; EHS has added some new courses and reached out to potential users of some of the more narrowly focused courses.
- Estimated time spent on classroom sessions by EHS staff includes 1,349 sessions x 3 hours/class = 4,047 hours; 4,047 training hours/1,920 hours = 2.04 FTE in FY2017.
- Slightly fewer (28%) EHS sessions were delivered by the web in FY2017 (average for past three years is 30%).
- The Division of Comparative Medicine conducts specific EHS training not included in this data. In FY2017, they had 1,484 online trainings and 4,388 classroom trainings completed.
- The percentage completion for PIs is lower than 90% for managing hazardous waste; in many cases, PIs do not actively manage work in a laboratory and technically do not require training, but 98% of PIs have taken the course at least once.

Table 1. Environment, Health, and Safety training completion and participation statistics, FY2013–FY2017

	FY2013		FY2014		FY2015		FY2016		FY2017	
	%	#	%	#	%	#	%	#	%	#
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
First-time trainees		1,683		1,904		2,025		1,953		1,900
PIs who completed hazardous waste training	67%	316	77%	326	73%	325	76%	321	67%	305
Total EHS web and classroom (includes Lincoln Laboratory)		**25,553**		**29,050**		**29,883**		**31,860**		**33,645**

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

Injury and Illness Report

Incident Reporting and Investigations

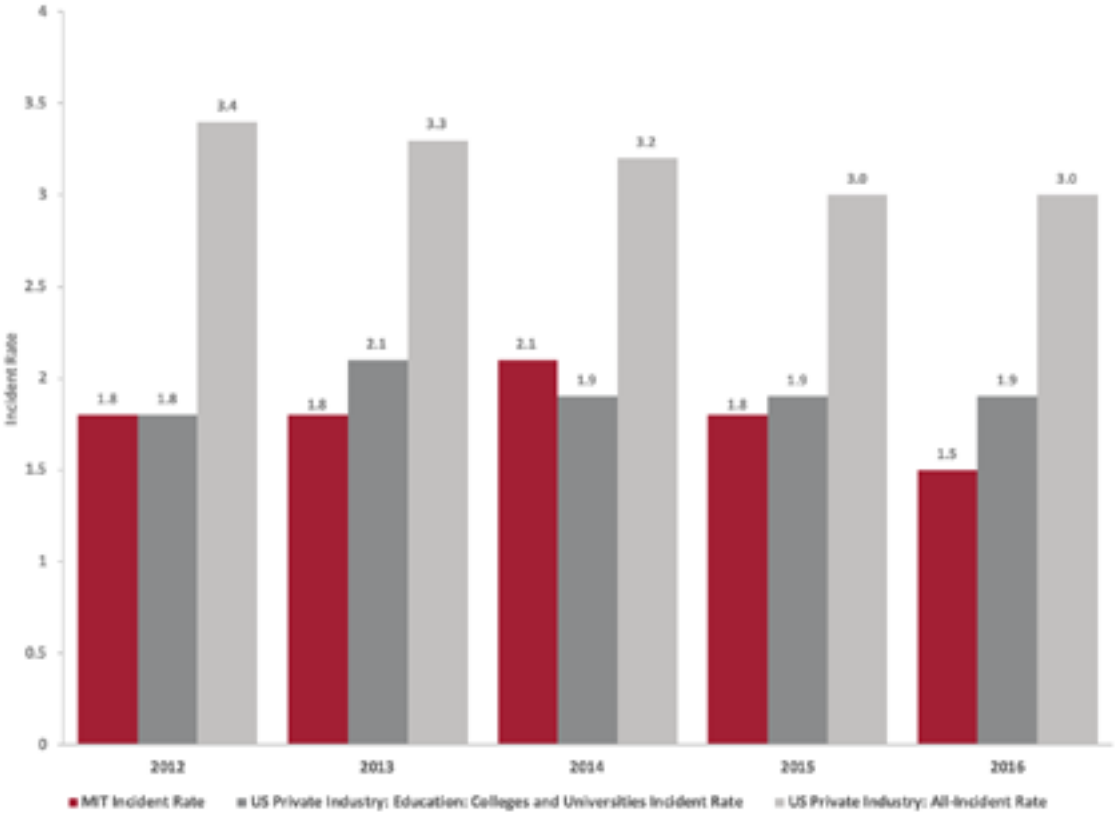
EHS works with DLCs on using the incident reporting and investigation system, which centralizes and electronically links all information related to an incident. The system offers online access to report injuries to Department of Facilities management, EHS staff, and DLCs' EHS coordinators.

As of January 1, 2015, OSHA updated its recordkeeping rule; 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 calendar year (CY) 2016, there were three cases that required EHS to make a report to OSHA. All cases involved employees who were hospitalized as inpatients overnight.

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. The incident rate of total recordable injury and illness cases for CY2016 (1.5) is shown in Figure 4, along with

data for the previous four years. This rate is below the CY2016 (using latest available data, from 2015) incident rate for private industry: education: colleges and universities (1.9) and the all-incident US private industry rate (3.0). The 2016 incident rate is also below the 2015 MIT incident rate, continuing a three-year trend of reduced recordable injury rates. A peer review of MIT's 2016 injury and illness data compared with the latest Bureau of Labor Statistics data (2015) can be found in Table 2.

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



Note: The 2016 all-incident US Private Industry Rate and the Education: Colleges and Universities rate, are 2015 rates; this is the most recent data. The incident rate of injuries and illnesses is computed from the following formula: (number of injuries and illnesses X 200,000)/employee hours worked = incident 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 incident rates.

Table 2. MIT 2016 Injury and Illness Data Compared to 2015 Bureau of Labor Statistics Data

Case type	MIT	All US Universities	All US Private Industry
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
Days Away, Restricted, and/or Transferred 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 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 DLCs

Much of the EHS oversight program is built upon the relationship between EHS staff, the PIs, and the PIs' laboratory groups. EHS meets with PIs to discuss their research and the risks inherent to the work and procedures, to assist with registrations, to conduct live trainings at laboratory group meetings, and to inspect (and just visit) the laboratories. The intent is that EHS remain a highly visible and easily approachable resource for researchers.

Table 3. Biological Research Registrations and Exposure Control Plans by School/Area (% of Total)

School/Area	Count	Percent
School of Engineering	126	34%
School of Science	105	28%
VP of Research	99	27%
Non-Research	16	4%
School of Architecture and Planning	12	3%
Provost	7	2%
Misc	10	3%
Total	**370**	**100%**

Note: The Non-Research category includes exposure control plans from the MIT Police; Housing Office; Department of Facilities; Endicott House; EHS; Department of Athletics, Physical Education, and Recreation; Property Office; Campus Activities Complex; MIT Medical; Division of Comparative Medicine; the Koch Institute; and Lincoln Laboratory. Miscellaneous includes the Dean of Undergraduate Education, Executive Vice President and Treasurer, and Provost areas.

There were 208 principal investigators representing 26 departments, labs, and centers.

Table 4. Radioactive Material Authorizations and Laser Registrations by School/Area (% of Total)

School/Area	Count	Percent
VP of Research	1,308	56%
School of Science	517	22%
School of Engineering	321	14%
Provost	98	4%
Misc	103	4%
Total	**2,347**	**100%**

Note: The Miscellaneous category includes the Whitehead Institute for Biomedical Research, Executive Vice President and Treasurer, and the School of Architecture and Planning areas.

There were 240 principal investigators representing 35 departments, labs, and centers.

Research Using Biological Material

Increase in Biological Research at MIT

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

Table 5. Biological Registrations and Exposure Control Plans Reviewed by the Biosafety Program

Type	Details
Biological research registrations (BRR)	• 243 biological research registrations have been reviewed by CAB/ESCRO (218 active registrations; 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), and Electrical Engineering and Computer Science(6)]. • The complexity of registrations increases over time with laboratories entering into multidisciplinary approaches to biological research.
Exposure control plans (ECP) for bloodborne pathogens	• 137 ECPs are associated with biological research (e.g., the Koch Institute, Biological Engineering, Biology). • 15 ECPs are non-research for employees who are expected to be in contact with blood (e.g., MIT Medical, MIT Police, Department of Facilities, EHS).

Another indication of the shift in biological research is the shift in containment levels of the biological research at MIT. The percentage of reviewed and approved biological research registrations (BRRs) considered to require biosafety level 1 containment measures has dropped over the past 19 years. Approximately 77% of the biological research conducted at MIT required biosafety level 2 or biosafety level 2+, which are higher containment levels. This is probably because of the large number of laboratories that use human materials and an increase in laboratories using various viral vectors, bacteria, or viruses.

Oversight Programs

As of April 2013, the NIH Guidelines were amended to extend the responsibilities of all institutional biosafety committees to include oversight of research involving synthetic nucleic acids. The change was made 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 the fact that this research had not been 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 10 years ago, well before regulations required it. The change in the regulations did not necessitate any changes in the EHS oversight program.

Biosafety Program and Office of Sponsored Programs Collaboration on Stem-Cell Research

The Biosafety Program within EHS has effectively collaborated with the OSP to ensure that copies of all CAB/ESCRO approval letters for use of human embryonic stem cells are sent to OSP as needed. The Biosafety Program also sends copies of state and federal assurance letters to OSP. Beyond the need to ensure appropriate funding for research based on human embryonic stem cells and induced pluripotent stem cells, access to the OSP grants database is helpful in predicting and understanding future areas of research growth.

Coordination of Research Compliance

Three oversight committees—CAB/ESCRO, the Committee on Animal Care, and the Committee on the Use of Humans as Experimental Subjects—carry oversight documentation responsibilities; they provide assurances to different federal agencies and must be registered with those agencies. Their compliance programs involve research approvals with various levels of review depending on risk. In several instances, there is overlap in committee responsibilities.

The deputy director of the Biosafety Program 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. The deputy director can identify overlapping 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 number of non-microbiologists working with biological materials has continued to increase. The newest trend in biological research over the past fiscal year was an increase in artists who want to perform wet laboratory 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 such work, have little or no previous experience or training in the techniques, and have developed almost all such projects with the goal of public exhibition.

To address some of these challenges, BSP has made efforts to connect artists with trained researchers to build collaborations that offer laboratory space as well as mentorship in developing the project and performing laboratory techniques. Most research groups use 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 makerspaces—places where specialized equipment is available to registered MIT users who can then use the equipment to test creative ideas. During the past year, the Biosafety Program assisted the Department of Biological Engineering with the creation of a new bio-makerspace on campus. This new project is akin to the many other makerspaces that allow participants to develop their own projects in a safe environment where members and supervisors promote a strong culture of safety. EHS expects other bio-makerspaces to be created on campus in the near future. To facilitate the expansion of these collaborative environments, the Biosafety Program sought suggestions and feedback from stakeholders, such as the

instructors that work in the Biological Engineering bio-makerspace, Professor Martin Culpepper and Research Scientist David Kong (from Mechanical Engineering and the Media Lab, respectively). Working with stakeholders, EHS is developing an accessible policy document approved by the CAB/ESCRO that describes the responsibilities of DLCs, PIs, supervisors, and participants in bio-makerspaces.

Although this meets the needs of research groups to find an 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. In circumstances where building a group's own laboratory is not feasible, the Biosafety Program has offered its laboratory space in N52 for short-term projects if the containment level is suitable. Members of the group receive hands-on training from Biosafety Program staff as needed in addition to taking all formal EHS training courses and laboratory-specific training. New programs to help train nontraditional wet laboratory researchers will be needed to support this meeting of disciplines in the future.

Public exhibition of biological projects adds another layer of risk. Exhibition requires transport of materials, construction of laboratory-like environments outside the laboratory, and the introduction of a new population (the public) that is less tightly controlled than trained research staff. Risk assessments of the few instances of public exhibition to date have included a case-by-case analysis of risks and what might possibly go wrong. MIT Medical and the Occupational Medicine and Employee Health Service, along with the Office of General Counsel, are consulted as necessary. Future development of laboratories with glass walls or windows that allow the viewing of projects without having to transport them and without direct interaction with the public may be a desirable design consideration.

Research Using Radiation-Producing Materials and Equipment

During the past year, the campus, Bates Center, and Reactor Radiation Protection Programs (RPPs) maintained a strong presence at MIT with the continued implementation of numerous service programs and interactions with faculty, postdoctoral associates, students, and staff. RPP staff performed radiation hazard risk analysis for proposed and continuing uses of licensed material and machine-produced radiation in RPP continuing programs for radioactive materials authorization, analytical x-ray machine registration, accelerator review and registration, experimental use and operations of the MIT research reactor, laser registration and safety, superconducting magnet registration and safety, and radio frequency (RF) source registration and safety. The demand for RPP services remained strong; demand for experimental reviews involving higher-powered laser and RF sources at the Lincoln Laboratory and the Haystack/Millstone Hill Observatory, and for routine and non-routine outages at the nuclear reactor, continued to increase.

Use of the Koch Institute positron emission tomography (PET) facility and radiochemistry laboratory continues to expand. There are now six authorized projects performing PET research. Demand for the facility is expected to continue to expand with new experimental protocols and the use of additional PET isotopes. RPP 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 cyclotron and an accelerator during the past year. RPP worked closely with Department of Nuclear Science and Engineering (NSE) and 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. RPP staff worked closely with NSE faculty and students to characterize the radiation fields from the new cyclotron at the Center for Science and Technology with Accelerators and Radiation. In preparation for the proposed Soonest/Smallest Private-Funded Affordable Robust Compact Reactor (SPARC) project, RPP worked closely with NSE and PSFC staff to monitor for free release all of the cement-block shielding in the NW21 west experimental hall, where the superconducting magnet development and manufacturing facility portion of the SPARC project will be. RPP staff attended several meetings with SPARC project faculty to discuss the radiation safety requirements for this project. The SPARC project team updated the radiation protection committee during their quarterly meeting.

RPP implemented the revised and updated Accelerator Safety Program. (There are currently nine accelerators on campus and two at the Bates Linear Accelerator Center.) The accelerator facility in the basement of NW13 is a great resource for the Institute and the RPP continues to work closely with facility staff as they enhance the safety systems, including interlock controls and active radiation monitoring systems. MIT continues to have three geographical locations designated for accelerator facilities: the Bates Center, Building N10, and Buildings NW13–NW21. The annual registration fee per location is $9,000. This registration system continues to save MIT $24,000 per year.

RPP implemented the new Massachusetts Radiation Control Program (MRCP) regulatory requirements for the security of the four irradiator facilities on campus. The new requirements include 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 the MIT Police, Information Systems and Technology, the Facilities Operations Center, and the lead RPP. The emergency response component of the program also involves the City of Cambridge police and fire departments. The new regulatory requirements also include an annual review of the security program by the MIT Police chief and radiation protection officer, an annual meeting with the Cambridge police and fire departments to review emergency response protocols, annual retraining for all irradiator facility users, and a 10-year reevaluation of users' criminal background history, including fingerprinting. RPP continues to work with community liaisons to provide radiation safety and emergency response training to the Cambridge police and fire departments as requested.

The functionality of the upgraded security systems for MIT's irradiator facilities is audited on a quarterly frequency. RPP assumed the quarterly security and alarm testing program for the gamma irradiator facilities, working in collaboration with the MIT Police, Information Systems and Technology, and the Department of Facilities Operations Center to manage and test these secure facilities. Members of the MIT Police received their required annual retraining on the irradiator security system and emergency response procedures.

As part of its agreement with the US Department of Energy, the Bates Linear Accelerator Center continued its clean-up of those accelerator systems that are not required for the Bates Center mission in the future. After receiving bids exceeding $500,000 to estimate costs for developing a decommissioning strategy, the Bates Center leadership and RPP 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 nonactivated components. This effort involved both radiation safety and asbestos control issues. On the basis of a successful result, it was concluded that future disposal options for the remaining dipoles located within the storage ring and the beam switch yard could include disassembling and holding activated components for long-term storage.

To reduce the risks to MIT grounds staff from the improper disposal of hypodermic needles, EHS installed a needle collection receptacle at the Cambridge and Somerville Program for Alcoholism and Drug Abuse Rehabilitation facility on Albany Street. EHS has been removing approximately 35 to 40 needles on a bimonthly frequency from this receptacle, reducing the risk of a needle stick to MIT grounds workers.

Table 6. Data Reflecting the Uses of Radiation Sources at MIT and Off-Campus Sites

Radiation source / equipment program	Current number	Reactor Radiation Protection Programs 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 (low-level)	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 and 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 MRCP conducted three 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 MIT's broad license #60-0094. The previous inspection was in 2013. The inspectors reviewed activities on campus, at the Bates Center, and Lincoln Laboratory. There were no items of noncompliance. During this inspection, the MRCP also inspected the security and emergency response programs associated with

MIT's irradiator facilities. The inspectors reviewed EHS's implementation of the new regulations that went into effect in January 2017. There were no items of noncompliance. In October, the MRCP conducted an accelerator inspection at the Bates Linear Accelerator Center. There were no items of noncompliance.

Major EHS Initiatives for FY2018

1. Reassess the EHS management system (EHS-MS) organizational structure for non-academic departments, starting with the Department of Facilities.
2. Collaborate with Facilities to implement the Institute's Laboratory Wastewater Master Plan.
3. Increase EHS efficiency and productivity by upgrading the office's technology.
4. Review and assess the EHS-MS with respect to the report of the Association of Public Land Grant Universities.
5. Support the dramatic increase in design and construction projects.
6. Complete rollout of the eShipGlobal program.
7. Continue the rollout of the Chemical Inventory Program.
8. Increase support to Lincoln Laboratory and other offsite facilities.
9. Develop new, and update existing, EHS training courses.
10. Develop and communicate 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 the EHS staff's professional development.
13. Develop new initiatives to enhance and add to MIT's culture of safety.
14. Develop the capability to develop new ideas and innovations to present EHS programs.
15. Continue and expand engagement with groups who have similar responsibilities within the DLCs, 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 Institute in expanding the makerspace program.
18. Investigate the risks of field work conducted by MIT personnel.
19. Collaborate with the Office of Emergency Management to enhance the Emergency Preparedness and Response Program.
20. Continue to work with the NSE faculty on the planning for the SPARC project.

Tolga Durak
Managing Director
Environmental Health and Safety Programs

Lou DiBerardinis
Director
Environment, Health, and Safety Office

Mitch Galanek
Associate Director

Pam Greenley
Associate Director

Nick Paquin
Deputy Director
Biosafety Program

Peter Bochnak
Deputy Director
Safety Program

William McCarthy
Deputy Director
Reactor Radiation Protection Program

Gerry Fallon
Deputy Director
Bates Radiation Protection Program